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NOTES.

The following is a translation of a circular signed by M. Mascart, as President of the International Congress of Electricians to be held in Paris from August 24th to 31st, and which we are requested to publish :—

"The International Congress of Electricians, which was held in Paris in 1881, marked an important date in the history of Electricity. The fixture of the practical units has had an influence upon the development of the science and of the industry whose importance it would be difficult to exaggerate. The ease and rapidity with which the decisions of the Congress were accepted, as well in the workshop as in the laboratory, demonstrates the utility of these assemblies, where all the talent and all the skill of the scientific world is brought to bear upon a common end.

"The International Exhibition of 1889 affords an opportunity for continuing and completing the work of 1881. Not that the new Congress will have to deal with problems of so general or so high an order as its predecessor, but many questions have yet to be decided upon which a common understanding, or at least an interchange of views, is desirable. In the programme which has been prepared the Committee of Organisation has not pretended to indicate all the subjects of discussion ; still less does it seek to impose any limit upon the activity of the Congress. It has merely desired to call attention to those subjects which appear to possess the most general and immediate interest.

"We believe that we are in accord with the unanimous sentiment of electricians in putting in the first line the following questions :— The practical measurement of electrical energy in all its forms : The measurement of current in absolute value by means of a standard easy to reproduce : Electric meters for direct and alternating currents : A practical standard of light : The definition of the constants of a machine upon a commercial basis.

"We hope that the *savants* and the manufacturers who have contributed to the progress and to the applications of electricity, and all persons who interest themselves in this novel department of human activity, will respond to this appeal, and will aid in giving to this reunion the importance and the authority of its predecessor.

"(Signed) E. Mascart."

The circular proceeds to give the full programme as drawn up by the Organising Committee, which, however, was published in this journal on December 14, 1888. Any one may become a member of the Congress on forwarding the sum of twenty francs to the President, at No. 44, Rue de Rennes, Paris.

At the *conversazione* of the Royal Society, held on Wednesday evening last, there were as usual many objects of interest to electricians, although the number of strictly electrical exhibits was not perhaps so great as on some former occasions. In one of the bays of the Principal Library Mr. Shelford Bidwell exhibited his beautiful experiment showing an effect of light on the magnetisation of iron (for which see *The Electrician* of March 22nd). Here also Dr. Gore displayed his Voltaic balance, (*The Electrician*, July 20th, 1888), an instrument which has not hitherto attracted much notice beyond the Royal Society itself, but which, we venture to predict, will before long be recognised as embodying a discovery of well-nigh the highest value and interest. Dr. Gore will not let us tell all we know about this matter just at present, but we hope that shortly our readers will have an opportunity of learning from Dr. Gore himself what this instrument is able to accomplish—and possibly they will be not a little surprised. Mr. J. W. Swan showed a little Gramme ring armature carrying a current of about half an ampere, and so delicately balanced that it rotated under the influence of the earth's magnetism alone. Mr. Killingworth Hedges exhibited an ingenious automatic safety device applied to a Kapp transformer. This consists of a small "vacuum tube" in an earth circuit, and so arranged that if the leakage current exceeds a certain amount it actuates a relay which short-circuits the primary. Mr. Vernon Boys exhibited a pair of gold leaves carrying an electric charge, and suspended from a quartz hook under a glass receiver, in an atmosphere kept moist with a dish of water. Here, where a glass support would allow the charge to be dissipated in a few seconds, the quartz maintains the insulation for four or five hours. It is still more strange to learn that if the quartz be actually dipped in water and put back in its place it insulates apparently as well as before. It is clear that henceforth nothing but quartz should be used wherever surface leakage has to be reduced to a minimum. Profs. Rücker and Thorpe exhibited a set of maps illustrating the direction and magnitude of the regional magnetic disturbing forces in the British Isles.

The above list completes the enumeration of the specifically electrical exhibits, but there were several others in which electricity played a part. Of these the most important was the Chronograph, exhibited by Captain Holden, R.A., for measuring the velocity of projectiles and small periods of time. Captain Holden has brought this apparatus to a state of great perfection. Prof. Norman Lockyer performed some most interesting experiments illustrating the probable origin of the aurora spectrum. Prof. W. N. Hartley showed some singular films of metals and metallic oxides deposited by the electric spark. In the Lecture Room Mr. E. S. Bruce exhibited a very beautiful effect obtained by an instrument which he calls the "Electric Graphoscope." It consists of a thin lath of wood

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which is rapidly revolved by an electric motor. On this a lantern slide is projected showing, say, a statue. The lath itself is then nearly if not quite invisible, and the image is apparently cast upon the air, giving an effect of bold relief. This is a very striking experiment—more so than it may appear from the description. Mr. MUYBRIDGE'S "Automatic Electro-Photographs," illustrating animal locomotion, excited the greatest possible interest, and this, together with the Tainter Graphophone (exhibited by permission of Mr. H. EDMUNDS), were perhaps the most popular features of the evening.

WE announced some time ago that in accordance with a suggestion made by the Electrical Trades Section of the L.C.C., the Board of Trade had consented to change the Unit of electrical supply from one thousand to ten thousand watt hours. This statement we made upon the authority of the Chairman of the Section; and, moreover, in all the Provisional Orders of the London Electric and the Metropolitan Companies the Unit is taken at the higher value. It will, however, be seen from our report that on the last day of the Board of Trade Inquiry, Major MARINDIN, much to the surprise of the counsel, stated that he understood the Board had decided not to sanction any change. In reply to a letter of inquiry we have received the following communication from the Secretary :—

"Board of Trade, Whitehall-gardens, S.W.

"SIR: In recent Licenses the Board of Trade have not made any alteration in the unit of supply.

"This decision was arrived at in consequence of careful consideration of advice given by a Committee of the Council of Electrical Engineers subsequently to the earlier representations to which you refer.—Yours faithfully,

"(Signed) COURTENAY BOYLE.

"May 9, 1889."

It is to be regretted that the Council of the Electrical Engineers should give contrary advice to that of the Electrical Trades on a point which involves no considerations of a scientific or even a technical character, but is purely a matter of commercial convenience.

THE United States' Patent Office has once more sprung a mine upon the unsuspecting and long-suffering electricians of that country. Seven years ago it appears that Mr. ED. WESTON filed an application for the grant of letters patent on the use of insulated iron plates in building up the core of an armature—a device which, it need hardly be said, is now of universal application. An "interference" was, however, entered by EDISON, who claimed the priority, and this has delayed the issue of the patent until the present time. The principal claim now admitted runs as follows :—

"1. In a dynamo-electric machine, the combination, with the shaft, of a cylinder or hub of insulating material secured thereon, iron plates or rings strung over said hub, and plates or sheets of insulating material interposed between said rings, these parts being constructed and combined in substantially the manner set forth for the reception of the coils."

The patent has been issued to the United States Electric Lighting Company, as assignees of ED. WESTON, but as we announced not long ago, this concern has passed into the hands of the Westinghouse Company, and already we hear that an infringement suit has been entered by the latter against the Fort Wayne Jenny Company. However superior the United States' Patent Laws may be to our own in some respects, it certainly appears that the operation of an "interference" sometimes causes grave injustice to be done, especially as an outsider has no means of knowing what applications have "interferences" pending, nor does an inventor know when, if ever, a patent may be issued to him.

WE understand that a scheme is on foot for the holding of an International Electrical Exhibition next year in Edinburgh. Judging from the success which has already attended the Birmingham Exhibition—where applications for space have far exceeded expectation—there can be little doubt that an Exhibition next year in Edinburgh, when counter-attractions will probably be less formidable, should prove an even greater success.

A STRONG feeling of indignation has been aroused amongst the holders of the instruments of the New Telephone Company by the manner in which the Directors have been induced to abandon them to the tender mercies of the Company whose patents are alleged to have been infringed. When it is understood that upwards of 8,000 instruments (every one bearing the inscription "fully guaranteed") have been disposed of, it will be admitted that the conduct of the Directors demands a further explanation than it has yet received. Whether or not it was the duty of the New Company to have resisted the claims of the United in a Court of Law is a point upon which we would express no opinion either one way or the other. It is useless to argue the question whether or not the "valve" transmitter is free from the Edison patent upon its own merits. If, when matters came to a crisis, the Directors arrived at the conclusion that their position was untenable, no doubt they should be praised rather than blamed for having avoided a further loss of the shareholders' money. But then of course they should have satisfied themselves on this point years ago, when the Company was first started; and meanwhile, what did they mean by "fully guaranteed?"

THERE is another point on which further information is very desirable. How comes it to pass that the United Telephone Company are demanding the surrender of the receivers as well as the transmitters? It is well known that the receivers of the New Telephone Company are made with the parchment diaphragm, which BELL found it necessary to disclaim. We need not go into the rights or wrongs of the manufacture, nor need we stay to inquire whether BELL or REISS was the true inventor of this type of receiver, but we do want to know upon what legal ground the United Telephone Company are actively confiscating the instruments. Information in our possession would lead us to believe that this step has been taken in consequence of an agreement between the respective companies, in virtue of which the Directors of the New Company are not to be held personally responsible for any infringement of which they may have been guilty upon condition that the receivers as well as transmitters were surrendered. If this be correct, we ask again, what becomes of the "full guarantee?"

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In view of recent action on the part of the English Telephone Companies, it is interesting to note that the American Bell Telephone Company is contemplating extensions on a very large scale to meet the demand for long-distance telephony. A petition has just been presented to the Committee of Mercantile Affairs by the above-named Company, praying for permission to increase its capital from ten million dollars to twenty million, the extra capital being needed chiefly for the erection of long lines. The wires being of copper, and doubled for each circuit, the neccessary expenditure will be far in excess of that required for similar lines of telegraph. Some of the lines are to consist of as many as 100 wires, and will cost $5,000 a mile. It is proposed to spend $7,000,000 or $8,000,000 in this way within the next three or four years if the Legislative Committee accede to the Company's petition.

As to the future of long-distance telephony, however, it is probably as unsafe to predict anything, one way or the other, as it was of long-listance telegraphy forty-two years ago. Mr. R. S. Cully, in the current number of *Blackfriars* (the Post Office magazine), recalls some of his experiences relating to that period, and among them his being discharged, or rather served with notice of dismissal, with a number of other officers, by the Electric Company in anticipation of its being *wound up!* So little did the public avail themselves of the telegraphic facilities then offered to them, that notwithstanding the most niggardly expenditure on its staff of employés, the Company decided to abandon the enterprise altogether as being financially a failure. Happily, before the notices expired better prospects set in; and a few years later the Electric Company was in a flourishing condition, which went on improving rapidly until 1870, when the country was glad to buy it out at a very handsome premium. It is not to be supposed that the collapse of the pioneer company would have extinguished electric telegraphy; but it must have been greatly delayed had not the Company plucked up courage to carry on the extensions so as to make them continuous and comprehensive. It attracted little notice while the lines were short disjointed lengths connecting one important town with another; but directly they were all joined together, and the system assumed a cohesive shape, business began to flow in and success was assured.

We understand that the negotiations between the Metropolitan Railway Company and the Electric Traction Company with reference to the working of the Metropolitan service by accumulators have now been definitely abandoned. We are neither sorry nor surprised at this result—in fact, we think that each company is to be congratulated on not having proceeded further with a scheme which from the first we have regarded as impracticable. More than a year ago, in our issue of April 27, 1888, we stated our reasons for this belief, but we also expressed a confident opinion that a well-considered scheme of direct current working would prove both practicable and economical. Subsequently, Mr. Sidney Evershed wrote a series of articles (*Electrician*, August 10, 1888, *et seq.*) in which the conditions of the problem were very fully considered. We should be delighted to hear that the Electric Traction Company had again taken the matter in hand on some such lines as those indicated.

Our American Notes have been delayed in transit and arrived too late for insertion this week.

Bognor.—The Local Board of Bognor are prepared to receive tenders for the lighting of the streets of that town by electricity. Further particulars will be found in our advertisement columns.

Personal.—We learn that Mr. A. E. Mavor, having completed his electric lighting duties at the Forth Bridge, has been appointed manager of the electrical department of Messrs. William Denny and Bros., Dumbarton.

St. John's.—The Town Council of St. John's (Canada) has decided to have the streets of that town lighted by electricity, and has signed a five years' contract with Messrs. C. F. Beauchennie and Co., of St. Jerome.

Elektrotechnische Zeitschrift.—We are informed that Herr Wabner has resigned the editorship of the *Elektrotechnische Zeitschrift* "on account of official promotion," and that Herr Petsch has now become editor of that journal.

Elieson Sale.—It will be seen by our advertisement columns that Messrs. Wheatley Kirk, Price and Goulty are instructed to sell piecemeal the entire plant and effects of the Elieson Electric Company. The sale will take place about the end of the present month.

Hull.—A meeting was recently held in Hull to consider the question of forming an electric lighting company, and it was decided after some discussion that the promoters should canvass the business part of the town, with a view to subsequently approaching the Corporation on the matter.

The Telephone in Cuba.—The *Gazeta de Madrid* invites tenders before the 28th June next for the installation and working of a telephone service in Havana. Tenders had previously been received and a contract awarded, but it fell through owing to the contractor not having made the required deposit within the period agreed upon.

Holborn Board of Works.—At a meeting of this Board on Monday last a letter was received from Messrs. Rooper and Co., on behalf of the Gwynne Electric Lighting Company, asking the consent of the Board to apply to the Board of Trade for a License to supply electricity in the district. The matter was referred to the Committee of Works.

Royal Society.—Mr. A. W. Ward read a Paper yesterday before the Royal Society "On the Magnetic Rotation of the Plane of Polarisation of Light in Doubly-Refracting Bodies," Dr. Hopkinson reading a Paper "On Magnetic and other Properties of Iron at a High Temperature," and Dr. Gore one "On Determining the Strength of Liquids by the Voltaic Balance."

Montreal.—The Royal Electric Company has secured the contract for the public lighting of Montreal. By the 1st July next the contractors are to have 663 2,000 candle-power arc lamps fitted in addition to the 137 already in operation. The lamps are to be kept lighted from dark till daylight at a cost of 40 cents per lamp per night, or about £30 per lamp per annum.

Spanish Telegraphs and the Press.—At the last Cabinet Council in Madrid the Minister of the Interior presented a project for the reduction of the tariff to the Press for messages sent during certain hours when the public service is less pressing. The Bill also provides for the hiring of telegraph wires by the newspapers, the income therefrom to be applied to the improvement of the telegraph service.

The Lighting of the Left Bank of the Seine.—The Conseil Municipal of Paris has granted an electric lighting concession for a district on the left bank of the Seine to MM. Nouvelle et Geisenberger. This district stretches from the river to the fortifications, and is bounded on one side by the Rue Saint Jacque, and the Rue de la Tombe-Issoire, and on the other by

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the Rue des Saints-Pères, the Rue du Cherche-Midi, and the Rue des Fourneaux.

Institute of Electrical Engineers—Students' Meeting.—A meeting was held on Friday, May 3, Mr. Alexander Siemens in the chair. Mr. Müller opened a discussion on Prof. Forbes' Paper on "Some European Central Lighting Stations and their Lessons." Messrs. W. H. Shepherd, T. L. Horn, C. H. Yeaman, J. N. Cooper, and the chairman continued the discussion. A hearty vote of thanks to Mr. Siemens for presiding terminated the proceedings.

Recent Thunderstorms.—Scotland and the North of England have been visited within the last few days by severe thunderstorms, during which several houses and persons have been struck by lightning. On Monday evening last an extraordinary thunderstorm occurred at Boulogne-sur-Mer; two horses were killed by lightning, and a man and a woman were also struck. The havoc made by the storm gives the town the appearance of having been visited by an earthquake.

Bedford.—At a meeting of the Bedford Urban Sanitary Authority last week the Gas and Electric Light Committee recommended the adoption of the electric light by the Corporation. The Committee gave elaborate statistics showing an estimated immediate clear gain to the borough of about £345 per annum. It was unanimously decided to obtain powers under the Electric Lighting Acts, and to employ an electrician to advise as to the establishment of the proposed installation.

Barnet.—The Barnet Local Board, at a special meeting held on the 25th ult., passed the following resolution unanimously:—"That having regard to the unsatisfactory manner in which Messrs. H. F. Joel and Company have lighted, and are lighting, the district of the Barnet Local Board, this authority do not consider it necessary or advisable to assent to or assist the undertakers in obtaining any powers from the Board of Trade under which they would acquire full control of the lighting of the district of this authority."

"Engineering" (Paris Exhibition Number).—Our contemporary, *Engineering*, issued last week a special double number in connection with the Paris Exhibition, which affords a most remarkable illustration of the enterprise of technical journalism in this country. The issue consisted of no less than 240 pages, of which 136 contained advertisements. The Exhibition Supplement consisted of 88 pages, and contains 254 engravings. It is scarcely necessary to add that the descriptive matter is fully up to our contemporary's usual high standard of excellence.

Reading.—At the meeting of the Reading Town Council last Thursday, the Highway Committee reported that the Chairman and one member of the Committee had been appointed a Sub-Committee to consider the whole subject of the lighting of the town, in view of the approaching termination of the existing contract with the Reading Gas Company, with a request that they would confer on the subject with the Gas Company, and with Messrs. Laing, Wharton and Down, who have established works in Reading, and whose lamps have recently been tested for a month in the centre of the town.

Ipswich.—At the monthly meeting of the Ipswich Scientific Society on Wednesday evening last week, Mr. W. B. Sisling, local representative of Messrs. Laurence, Paris and Scott, delivered a lecture on the "Transmission of Energy by Electricity." Mr. Sisling practically exemplified the electric transmission of power by sending the current on a small scale necessary to light two 16-candle lamps from two small dynamos in series through many yards of the finest iron wire. Mr. Sisling's lecture was listened to with the greatest interest. Several questions were asked of the lecturer, and a hearty vote of thanks to him concluded the meeting.

The Bellegarde Central Station.—The central lighting station at Bellegarde (Ain), which has been in continuous operation since February, 1884, and which at the present moment has an output of 3,500 horse-power, has lately inaugurated a system of electrical distribution for power purposes. The charge is 200fr. per horse-power per annum up to 50 horse-power, and 150fr. per horse-power per annum over that amount. The current is on day and night. For motors of less than 40 horse-power and within a kilometre of the station the pressure is 100 volts; for larger motors and longer distances 300 volts are employed.

Export Catalogue of Machinery and Hardwares.—The fourth annual edition of this useful publication, which is brought out by the Machinery and Hardware Company, now extends to close upon 150 pages, and contains the quotations of a large number of well-known firms. By means of this catalogue manufacturers are enabled at a greatly reduced individual cost to bring their specialities prominently before buyers all over the world. The catalogue is published annually, and copies are circulated all over India, the Colonies, and the Continent generally. The list of electrical firms making use of this medium contains first-rate names, but the number is very small indeed.

Newcastle Electric Supply Company.—On May 6th the statutory first general meeting of this company was held at its offices, 1, St. Nicholas's-buildings, Newcastle, Alderman T. G. Gibson in the chair. The Chairman explained that the consent of the Newcastle-upon-Tyne Corporation had been obtained to the Company's License, and that the Company's License had been favourably considered by the Board of Trade, who had intimated that it would be granted at the end of the statutory period. The Chairman further stated that a site had been acquired for the company's works, tenders for buildings accepted, and plant ordered and in course of construction. The directors were re-appointed with important additions, and a vote of thanks to the Chairman closed the proceedings.

Exports of Electrical Apparatus.—The Board of Trade returns for April, issued this week, are again of an exceptionally favourable nature. The April shipments of telegraphic wire, &c., were small, but that is not surprising having regard to the abnormally large exports of March last. The following is a comparative statement of the exports of wire, &c., for the month and for the four months:—

	1887.	1888.	1889.
January.....	£14,442	£41,231	£112,230
February ...	44,137	14,051	32,086
March	73,300	32,795	285,993
First quarter	£131,879	£88,077	£430,309
April	27,616	27,012	13,032
Four months	£159,495	£115,089	£443,341

Liverpool.—At a meeting of the Liverpool Town Council on Wednesday last week, Alderman John Hughes moved that the consent of the Council be given to the request of the Liverpool Electric Supply Company for the consent of the Corporation to their application to the Board of Trade for a Provisional Order. The term for the powers of the company is twenty-one years, and at the end of that time it will be competent for the Corporation to acquire the rights of the company at arbitration. A maximum rate of interest to the shareholders of the company has been fixed; after 7 per cent. has been paid the interest beyond that amount is to be divided, one-half going to the shareholders and the other half being devoted to the easements of the rates. Under the company's agreement with the Corporation the latter also has power to audit the accounts of the company and to examine their books. The resolution was adopted.

Paddington and the Electric Light.—At the last meeting of the Paddington Electric Lighting Committee the following resolutions were carried:—

"1. That while the Report of Prof. Forbes, F.R.S., M.Inst.C.E., shows that the Vestry might secure many advantages to the Borough by itself undertaking the introduction of the electric light, before coming to any decision on the question steps be taken to obtain proposals for doing it by private enterprise, so that the several schemes may be compared and considered in time for the Vestry to agree to the necessary notices and applications being made under the Electric Lighting Acts for the Session of 1890.

"2. That in order to carry out this policy a Sub-Committee of seven members be appointed to obtain by advertisement or otherwise proposals from companies and others for the supply of electricty for lighting purposes.

"3. That it be an instruction to the Sub-Committee to arrange that all proposals shall be sent in on a uniform basis, to be subsequently agreed upon at an adjourned meeting of this Committee, subject first to approval by the Vestry."

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THE ELECTRIC LIGHTING OF THE PARIS EXHIBITION.

Although the earning capacity of an Exhibition depends to so large an extent upon the total number of hours during which the public has access to it, and although the adoption of the electric light is such an important factor in increasing the number of "working" hours, the French Government have preferred to hand over the electric lighting of the Exhibition to a syndicate rather than undertake the matter themselves, or pay for the light at a fixed rate as in the case of gas. The following details of the lighting will be of interest at the present moment.

The idea of undertaking the lighting on the present lines occurred at an early date to M. G. Berger, who suggested it to the Chambre Syndicale des Électriciens. The Chambre Syndicale forthwith delegated MM. Lemonnier and Hippolyte Fontaine to study the subject and enter into communication with the State. The upshot of these inquiries and negotiations was that the Minister of Commerce and Industry gave permission to the Syndicate International, upon certain well-defined conditions, to light the Palais des Machines, the gardens on the Champs de Mars, and various other sites in the vicinity. The agreement and statutes of the syndicate, accompanied by a *cahier des charges* drawn up for the Commission Technique d'Électricité, of which M. Mascart is president, were signed on the 15th February, 1888. The Syndicat International des Électriciens is a company with a capital of 300,000fr., founded by the firms of Gramme, Edison, Sautter-Lemmonier and l'Éclairage Électrique, and its object is to undertake the private and public electric lighting of the Exhibition. The Conseil d'Administration appointed by statute consists of MM. Fontaine, Lemonnier, Raw, and Fabry. The profits of the concern are to come from the gate-money received of an evening, the price of admission being 2fr. on week days and 1fr. on Sundays. The syndicate agrees to give the State half the gross receipts up to 3,600,000fr.; when the receipts exceed this sum the portions to be given to the State will be seven, eight, and nine-tenths of the gross receipts until they reach the sum of 4,600,000fr. Some 26 firms replied to the circular sent out by the syndicate; of these 16 were French, 5 Belgian, 2 English, 2 Swiss, and 1 Alsatian. M. de Bovet was now made chairman of the company, M. Picou chief engineer, and MM. Napoli, Dumont, Révérénd and Lafon inspectors of works. The public lighting is carried out as follows:—

Buildings.—The Palais des Machines is a magnificent hall 383 metres long, 114 metres wide, and 45 metres high, with two galleries 18 metres in width running all round it, the total floor space amounting to 77,000 square metres. The lighting is provided by two independent sets of apparatus. The first set comprises no less than 48 arcs taking 60 amperes each—they are without globes, and are placed at an elevation of 40 metres. These huge lamps are supplied by the Gramme Company. The second set comprises 86 25-ampere arcs, placed in five rows at an elevation of 15 metres. These lamps are supplied by the following firms:—Crompton, 24; Ducommun, 20; Sautter-Lemonnier, 12; Jaspar, 10; Société Belge, 6; Borssat, 6; Société Française, 4; Henrion, 4. The upper gallery will be lighted by 276 8-ampere arcs placed at a height of five metres. Of these Crompton furnishes 79; Ducommun, 76; Sautter-Lemonnier, 30; Oerlikon, 25; Société Française, 8; Société Belge, 8; Henrion, 8; Jaspar, 7; Popp, 5. The staircase in the transverse axis, near the École-Militaire, will be lighted by 200 eight candle-power Woodhouse and Rawson lamps; the offices under the staircase by Garnot with 10 250 candle-power lamps; the staircase opening out on to the Avenue de Suffren by Jarriant with 360 eight candle-power lamps; and the staircase near the Avenue de la Bourdonnais by Crompton with 160 eight candle-power lamps.

The railway annexe, with a superficies of 5,718 square metres, is illuminated by five 25-ampere and 30 8-ampere Borssat arc lamps. The Société des Forges et Chantiers de la Méditerranée lights the hall in front of the grand staircase with 10 8-ampere arcs and 320 10 candle-power incandescents. The gallery uniting the hall and the central dome is supplied with 48 8-ampere Cance lamps, the dome itself being lighted by 48 500 candle-power lamps supplied by the Gramme Company. The buildings at the back of the Bureau des Brevets is lighted by 16 "Soleil" lamps. The front of the building is illuminated by 16 8-ampere and three 16-ampere arcs, furnished by the Société pour la Transmission de la Force Motrice par l'Électricité. The Gramme Company will light the staircases by eight 500 candle-power incandescents, and the upper gallery by 10 500 candle-power incandescents. The Edison Company has installed three groups of 6 8-ampere arcs in the Galérie Rapp, as well as 26 8-ampere arcs generally distributed. The same company provides 400 8 candle-power lamps in the "Pavillon de l'Administration et de la Direction Générale."

Open Spaces.—These are lighted by 18 8-ampere arcs furnished by the firm of Ducommun, of Mulhouse, and by 22 arcs supplied by the Edison Company.

Upper Garden.—The lighting of this garden has been entrusted to the Société pour la Transport de la Force and to the Société pour la Soudure des Métaux. The former employs 72 8-ampere arcs, and the latter 850 4 candle-power and 100 8 candle-power lamps.

Central Garden.—The lighting of this garden is in the hands of the Edison Company and the Société d'Éclairage Électrique. The Edison Company has installed 33 8-ampere arcs, 100 8 candle-power, and 5,000 4 candle-power incandescents.

Lower Garden.—The lighting of this section comprises 60 8-ampere and 8 25-ampere arcs.

The banks of the Seine are lighted by 75 8-ampere arcs.

The illuminated fountains require eighteen 60-ampere and 30 40-ampere arcs. The total candle-power of the arc lamps amounts to 1,500,000 candles, and that of the incandescent lamps to 100,000 candles.

The electric plant supplying all these lights is grouped together in six central stations. The Gramme station has an area of 640 square metres, and the plant comprises nine Davey-Paxman locomotive boilers, three Davey-Paxman compound engines, developing a total of 700 horse-power, two 175 horse-power dynamos, and three 100 horse-power compound-wound dynamos, giving 110 volts at the terminals. The Edison station has an area of 400 square metres, and the plant comprises four 150 horse-power Belleville boilers, four 150 horse-power Weyher and Richemond engines, two 100 horse-power and six 50 horse-power Edison dynamos. The Jablochkoff station, belonging to the Société d'Éclairage Électrique, has an area of 400 square metres, and a total available power of 600 horse-power. The plant comprises four Terme and Deharbe boilers, four 150 horse-power Lecouteux and Garnier engines, and 19 dynamos, viz., eight Gramme alternators, 10 Rechnervski continuous-current machines, and one Ferranti alternator. The station belonging to the Société pour la Transmission de la Force contains two 500 horse-power Corliss engines, fed by multitubular Roser boilers and four 200 horse-power Marcel-Deprez dynamos. The Ducommun station contains 15 dynamos, having a total output of 300 horses, supplied by Lagosse boilers and Ducommun engines. The station belonging to the Syndicat International has an area of 320 square metres, and the total available horse-power amounts to 400, the boilers and engines being of various types. The electrical plant consists of two 100 horse-power Borssat dynamos, one 50 horse-power dynamo, and one 30 horse-power dynamo, together with a Parsons turbo-electric generator. The total power available for electric lighting purposes amounts to something like 4,000 horse-power, in addition to the 10,000 kilogrammes of accumulators.

The well-known firm of engineers, Messrs. Davey, Paxman and Co., of Colchester, whose engines and boilers have acquired a world-wide reputation, have sent to the Paris Exhibition such a fine and various collection of steam motors, generators and mining machinery as will add not only to the credit of the Colchester firm, but will prove to the visitors of the Exhibition that Great Britain still maintains the first position in the manufacture of steam engines and boilers. Messrs. Davey, Paxman and Co. exhibit steam engines and boilers of about 1,500 total horse-power, out of which about 300 horse-power is for supplying the motive power required in the British

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section. This power is given off by two engines, both of which are condensing, one of the coupled compound girder type and the other of the horizontal girder frame type. The remaining power, which is used for driving electric lighting machinery, consists of three engines, all of the compound receiver type, one 500 horse-power coupled compound girder engine and two of the well-known "Colchester" type. One small horizontal engine is used for driving the mechanical stokers of the group of nine locomotive multitubular boilers which are supplying the necessary steam for the engines.

(FROM OUR SPECIAL CORRESPONDENT).

PARIS, *May* 7, 1889.

The Universal Exhibition was opened on Monday afternoon, at 2 p.m., and remained open until midnight. The crowd was immense, and no less than 250,000 paying entries are said to have been registered. Although it was not ready in the full sense of the word, the Exhibition was in a much more advanced state than is usually the case, and it will be complete in the course of a fortnight. From what was to be seen of the electrical illuminations one may obtain some idea of what it will be when finished, although not half of the lamps were yesterday alight.

The fact that the International Electrical Syndicate, controlling the lighting of the Exhibition, have available some 4,000 horse-power for the purpose will convey some idea of the amount of mechanical and electrical machinery brought into requisition, while the diversified systems of lighting and machinery employed, owing to its international character, lends a special interest to the British electrical engineer. Although only two out of the six large central stations are now running, namely, the Edison and the Gramme, there are three others, the Deprez, the Jablochkoff, and the Syndicate, which are very near completion. The illuminations on the opening night were chiefly supplied by the Gramme-Davy-Paxman Station. At nine o'clock a gun fired from the Eiffel Tower announced the starting of the luminous fountains, the display of which was really marvellous. They played about twenty minutes, and the public frequently cheered and applauded.

The Edison Station ran six 600-light dynamos, with three Weyher and Richemond engines, and produced a most brilliant effect with arc lights in the Galerie Rapp, where the statuary is collected, and round the lawns and walks with incandescent lamps. The Terme and Deharbe boilers which are to supply steam to the Jablochkoff Central Station (Société L'Éclairage Électrique) not being ready in time, the company ran some 90 Jablochkoff candles in the grounds and along the façade of the Palais des Arts Liberaux, by means of three 30 horse-power and one 10 horse-power portable engines running six alternating Gramme dynamos. The improvised mains were overhead, but the permanent "canalisation" is underground, and connects one transformer to each lamp of six candles. This is enclosed in a test box contained in the lamp-post, and all transformers are in series. The potential is neither transformed up nor down, but the transformer simply serves the purpose of preventing a disconnection of the entire circuit when one lamp fails. The whole of the façade of the Palais des Beaux Arts was illuminated by 34 Gramme arc lamps run by a small plant in the machinery hall. This is installed by the Compagnie Electrique, and consists of four high-tension Gramme dynamos, run from a 50 horse-power "Otto" gas engine. The chief interest lay in the method of driving, which was by friction, one countershaft pulley driving two dynamos, the latter being inclined so as to cause the pulleys to grip. Another electric sub-station running from the Machinery Hall was that of Messrs. Sautter and Lemonnier. Some 28 arcs were run to light one of the large restaurants, the plant consisting of an eight-pole continuous current dynamo run direct off a 100 horse-power vertical compound high-speed engine. From this station will also be run 42 arcs, as part of the general illumination of the Machinery Hall. This vast and noble structure presented a far more complete appearance as regards the exhibits than many of the most sanguine, who knew the state it was in a few days ago, could have ventured to anticipate. Edison's prominent *emplacement* draws attention immediately. Here are phonographs and an array of the latest telegraphic devices, in addition to a complete central-station plant on the three-wire system, underground conductors, dynamos, switchboard, and regulating appliances. The dynamo, lamps and fittings which are comprised in the Edison "Municipal" system of street lighting by incandescent lamps will attract attention. The gigantic Edison lamp, which has been built up out of some 25,000 incandescent lamps, is to be lighted by a number of red-coloured lamps inside the others, placed in the form of a filament. The 100,000 candle-power arc light placed on the top of the Eiffel Tower, and the two search-lights of the same candle-power erected on the platform at 280 metres from the ground, produced a splendid effect, and were also very much admired. The height of the top of the lantern above the ground is 984ft., though, so far as the general public is concerned, the Tower terminates at a height of 896ft., where there is a platform some 53ft. square, above which rise four latticed arched girders, uniting at a height of 54ft. above the platform (*see* Figure). By means of a spiral stair-

Summit of the Eiffel Tower.

case yet another gallery is reached, which is 46ft. higher, and above this rises the great lightning rod.

The idea originally propounded was to turn the Tower at night-time into a veritable pillar of fire by the use of innumerable arc and incandescent lamps. On account of the enormous expense, however, the scheme was abandoned, and the electric light is confined to the three large projectors at the summit, each of which is run off its own dynamo, placed at the base of the tower in the south-west leg. The current is taken to the lamps by means of bare stranded copper cables run on insulators. In the lower lantern there are two 100-ampere Mangin projectors made by MM. Sautter, Lemonnier and Co., which are worked by hand, and provided with Morse apparatus for the purpose

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of flashing military signals. Above these lights is the lantern proper, containing an illuminating apparatus such as is used in the first-class lighthouses along the coast of France, and projecting red, white and blue beams over Paris and the adjacent country. The clockwork hitherto invariably employed in all lighthouses having revolving lights is, however, replaced by an electric motor.

In addition to the lighting, there are several points connected with this great Tower of interest to electricians. During the building of the Tower the telephone proved of great use as a means of communication between the men at work at the top and those engaged below; and the various platforms are now all permanently in telephonic connection with one another. Special provision has been made to protect this huge lightning conductor from lightning. Eight cast-iron pipes, 19in. in diameter, connected to the ironwork of the structure, pass through to the water-bearing strata, 60ft. below the level of the Seine, while at the summit soars a long pointed rod of the ordinary description.

Bent on vindicating the practical utility of the Eiffel Tower, the French have been at great pains to enumerate the various scientific possibilities of the structure. First and foremost, there is the laboratory at the top, for which great things are predicted in the way of meteorological observations and discoveries in atmospheric electricity. Valuable astronomical and optical observations are also expected to be made from the summit, while, according to M. Max de Nansouty, if Paris had possessed *le tour Eiffel* in 1870 the issue of the great siege might have been different. "The optical telegraph, whose functions, combined with secret correspondence, have attained remarkable perfection, would have established permanent communication between Paris, Rouen, and the provinces. Nothing could have stopped or interrupted these signals, which would have contributed to unite all the armies organised in the provinces against the investing forces."

THE CARSTAIRS ELECTRIC RAILWAY.

Messrs. Anderson and Munro, of Glasgow, are now putting the finishing touches to this, the first electric railway in Scotland. It extends from Carstairs House, the residence of Joseph Monteith, Esq., to Carstairs Junction, on the Caledonian Railway system. It has been constructed chiefly as a means of rapid and always ready communication between the station and Mansion House, but it has branches and sidings so that it may serve for local farm and estate traffic. The line runs for a mile and a-quarter through some of the most beautiful scenery on the Carstairs estate. Owing to the absence of all smoke, dirt, or noise, it will not in the least mar the charm of its surroundings. The conductors are rectangular rods of very pure iron, arranged, the positive on the one side, the negative on the other, about a foot outside of the rails. They are attached to specially designed insulators by an elastic steel fastening, which allows of no side shake, but permits the rods to expand freely, and which can be easily replaced should any insulator get broken. The insulators are in turn supported on iron rods, rising some 10in. from the sleepers to which they are attached. The gauge is 30in. A handsome electric carriage is being constructed, and during the trial runs a speed of 35 miles an hour was attained, and could have been easily surpassed. At all speeds the motion was exceedingly smooth and pleasant.

The source of power is a waterfall three miles distant. When the car is at the station end, therefore, the current traverses eight and a-half miles of conductor. As the Mansion House had to be lit throughout by the same current, and as it was necessary to keep the potential difference under 250 volts at the railway to obviate danger from shock, and the size of conductor small on account of its length, it will be seen that an interesting problem was presented for solution. Fortunately there was ample water-power to waste, so a series-wound dynamo of Goolden type, giving 400 volts and about 40 amperes, was placed beside the turbine, and current was carried over the three miles to the Mansion House along four bare copper wires run on fluid insulators. "Earth" is nowhere used, the circuit being metallic and insulated throughout. At the house there is placed a battery of 100 E.P.S. cells, which are charged all in series. This battery, when discharging, has the house wires so joined up that one half supplies one section of the house and the other half another section, although, when lighting lamps only, it can be transformed into one battery of 100 volts, the two halves being then in parallel. The cars can be run from the cells alone, from the dynamo alone, or from both coupled. The varying demands for current produce large variations of field-magnet strength, and consequently of E.M.F. at the terminals of the series dynamo, but, on the other hand, the large line resistance causes fluctuations in the opposite direction in the amount of loss in the line. This loss varies from 10 up to 150 volts. The dynamo characteristic and the line resistance have been so adjusted that within a working range of current strength the potential difference at the house switchboard is approximately 250 volts. An automatic appliance keeps the current flowing always within the desired range, so that even if all load is thrown off there is not more than 250 volts on the railway conductors, nor are the field magnets demagnetised. At present an attendant living near by starts and stops the dynamo on receipt of a signal; but it is the intention to put in a small motor to put off and on the water supply. A pair of smaller brushes will be placed midway on either side between the chief collecting brushes, and the small brushes coupled together are joined to the signalling wire after passing through the armature of the small motor. The field magnets of the motor are a shunt on the main wires. By joining the accumulator end of the signalling wire to the positive or negative main respectively a current flows through the small motor armature in one or the other direction. Thus, by putting a switch at the house to right or to left, the water can be put off or on at the turbine three miles distant. We hope to give drawings of the car when it is completed, showing details of its mechanism. The whole system has been designed by Mr. John M. M. Munro (of Anderson and Munro, the contractors for the work), and carried out under his superintendence. Mr. Monteith, who is himself a skilful engineer, has taken a close personal interest in the construction of this railway, and with Mr. David Hunter, of Lanark, has materially contributed to its success.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"On Lightning, Lightning Conductors, and Lightning Protectors."*

BY DR. OLIVER LODGE, F.R.S.

(Continued from page 734.)

MATERIAL OF THE LIGHTNING CONDUCTOR.

25. A few words may suffice to explain the nature of the impedance which alternating currents meet with in passing through a conductor, and of the reason why iron is as good as, or even better than, copper for the purpose of conveying currents alternating with extreme rapidity.

A rising current has to magnetise the space all around it, and the production of this magnetisation delays and impedes the rise of the current to its maximum value. A falling current permits the magnetisation of the space all round it to decay, and the dying out of this magnetisation delays and impedes the fall of the current to its minimum. The more rapidly the current changes the more powerfully felt is the influence of the accompanying magnetisations and demagnetisations. Now the total magnetisation produced by a current—its total number of lines of force, or its total "magnetic *induction*," as it is often called—is proportional to the current strength; equal to it multiplied by some constant, which we may call L, and write

$$I = L C,$$

where I is the total induction produced by the current C. L is a coefficient characteristic of the circuit, its value being defined by this equation, and is called the coefficient of induction excited by the current's own self, or the coefficient of self-induction.

* Paper read before the Institution of Electrical Engineers on Thursday April 25, 1889.

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If the current goes through $p/2\pi$ complete alternations in a second, it can be shown that the impedance it meets with, due to the reversals and re-reversals of its own magnetic field, is p L.

This is not the whole obstruction it meets with, but it is the only part which does not dissipate energy and cause its vibrations to decay. It may be called the *inertia* part of the impedance. The remaining part of the total impedance is resistance, R, the dissipation of energy coefficient, defined by

$$\text{heat per second} = \text{R C}^2 ;$$

and the total is the resultant of these two as if they were at right angles to each other. So that, calling P the total impedance,

$$P^2 = (p\,L)^2 + R^2.$$

Now in respect of the R term, iron is much worse than copper, not only seven times worse, hundreds of times worse ; but then for very rapid alternations the R term is altogether insignificant compared with the p L term.

26. In respect of the p L term does the material of the conductor matter ?

Well, in so far as the magnetisation spoken of is that of the space surrounding the conductor, of course the substance of the conductor itself matters nothing. But in so far as the conductor itself gets magnetised, the material of which it is made does matter. Now a linear current magnetises at right angles to itself everything surrounding it—most intensely the things close to it. A hollow cylindrical current magnetises everything outside itself, but nothing inside. If the current were to distribute itself uniformly through the section of the wire, the outside of the wire would get magnetised in concentric cylinders ; but if the current were to confine itself to the outer surface, and flow as a hollow cylinder, it would escape the necessity of magnetising the wire at all. In cases where the p L term is much more important than the R term this is precisely what it does therefore. It always flows so as to meet with the least possible total obstruction ; and it finds less total obstruction by cramping itself into the periphery of the wire than it would find if it utilised the whole section. The cramping into the periphery increases R, but it decreases p L ; and on the whole with rapidly alternating currents this is an advantage, and gives a smaller value to P.

Slowly changing currents think most about R, and use the biggest cross-section they can find. Rapidly changing currents think most about p L, and avoid having to magnetise more than they need. Especially must they avoid having to magnetise the conductor if it consists of iron : hence in that case they cramp themselves tremendously into its outer skin, and thereby avoid having to overcome much more total impedance than they meet with in the case of copper ; but though they thus keep down impedance, they increase their dissipation of energy term, and get their oscillations damped out far more quickly than when they only have to pass through copper. The violence of the flash therefore subsides more quickly in an iron than it does in a copper conductor, and so I find it experimentally.

Nothing here said is in the least hypothetical. It is all absolutely clear and certain, and has been abundantly verified. I will not go into the history of the subject. It is well known.

27. Let it be clearly understood, once for all, that in comparing copper and iron conductors I never mean comparing them as of unequal thickness, *i.e.*, of equal conductivity. Such a comparison is ridiculous in the present state of knowledge. They are to be compared when of the *same* thickness ; and under those circumstances I assert iron to be a trifle better, certainly not a whit worse, than copper ; irrespective of all its other manifest advantages, cheapness, fusing-point, &c., &c. Want of flexibility is sometimes urged against iron, but stout telegraph wire is flexible enough ; and, until experience decides to the contrary, I feel sure it is thick enough for lightning conductors.

The one and only thing on which anything can be said against iron is on the subject of its durability, and this being a chemical question I offer no positive opinion ; at the same time I am absolutely certain that any slight disadvantage in that respect is a hundredfold compensated in most localities by its other superlative advantages.

Current and Potentials during Discharge.

28. In cases where a conductor is pretty thick, say, anything like a quarter inch diameter, or even a tenth, and of any moderate length, such as 100 yards or less (not many miles), the two terms of impedance are so unequal that it is for many purposes needless to think about R at all, the impedance is practically p L simply ; and this, as I have shown in *Phil. Mag.*, August, 1887, is under any given circumstances half the critical *resistance* which determines whether the discharge shall be oscillatory or not under the same circumstances. The total impedance is commonly to be reckoned in hundred or even thousands of ohms.

29. The strength of current passing in the alternations can be estimated by considering that the whole quantity stored up in the discharged body has to be transmitted in a quarter of one oscillation period—say, for instance, in the millionth of a second. If the quantity discharged were one coulomb this would mean a current of a million amperes. In any case the current must be hundreds or thousands of amperes.

30. The difference of potential needed to drive so strong a current through so great an obstruction is enormous, being equal to the product P C, and may be reckoned in millions or hundreds of millions of volts ; hence it is that lightning conductors afford no easy path for lightning, but that it tends to spit off in all directions, even to what would seem, and indeed are, very inferior conductors. It will spit off from a well-earthed stout copper rod to bits of wood and to perfectly insulated bodies.

Effects in the Neighbourhood of a Discharge.

31. Putting together the enormous electrostatic potentials existing at the different points of a conductor conveying a discharge, and the violent oscillation to which so strong a current is subject, we perceive how great must be both the electrostatic and the electromagnetic induction in all space anywhere near it.

These disturbances, thus rendered certain and accounted for, can easily be experienced experimentally. I proceed to relate a few experiments out of a multitude which I have made.

32. I took a considerable length of highest conductivity No. O electrolytic copper wire, kindly lent me by Messrs. Thomas Bolton and Sons, and arranging one end so as to be accessible to Leyden jars, &c., carried the wire up to a high gallery and then down to earth. Earth was made in several ways on different occasions : water pipes, gas pipes, hot-water pipes which ramified the whole building, outside gas mains, bars buried in ground ; but the most effective and, indeed, perfect return circuit could be had when wanted by connecting the end metallically with the outside coat of the jar, without any earth contact at all. When this direct contact was not made, the outer coat of jar had of course to be connected to earth also, in order to complete the circuit. Very often they were both connected to each other and to earth as well. It makes no essential difference ; whatever may be considered the most satisfactory method, that may be adopted, and the phenomena will go on just as well. They may be briefly summarised as follows :—

1. If the conductor pass within an inch or two of any uninsulated piece of metal, it gives off a violent side flash to it.

If the far end of the conductor is neither earthed nor connected to jar, but is left insulated in air, side-flashing from it occurs a trifle more easily, but not very markedly so.

2. If the conductor pass within, say, half an inch of an insulated conductor, it gives off a side flash to it ; the strength of the flash depends on the capacity of the insulated conductor, being considerable if it be large ; but some side spark occurs to an absurdly small body perfectly insulated, *e.g.*, such a thing as a coin on a stick of sealing wax, and this when the conductor is absolutely well earthed at its far end.

3. Sparks can be obtained from anything, even quite uninsulated things, connected to the conductor ; for instance, if it be connected to the gas pipes, small sparks will fly to the finger or to an insulated body from all the gas brackets about, and these sparks are sufficient to ignite gas.

4. Sparks can be obtained between the ends of any long curved conductor, be it insulated or uninsulated, if they are brought close enough together to form a nearly closed circuit.

5. Sparks can be obtained from or between insulated bodies in the neighbourhood of the conductor, and not connected to it at all, every time a flash occurs.

For instance, a large piece of wire gauze connected to nothing gave off sparks to a gas bracket and ignited the gas. Moreover, one piece of wire gauze sparked small sparks into another, neither connected with anything.

6. Sparks can be obtained from quite uninsulated bodies, even when not connected with the conductor, *e.g.*, from hot-water pipes, from gas pipes, from water pipes, from strips of brass let into the table, from gas brackets in other rooms, from a wire lying on the floor of a distant corridor ; and, in fact, all over the building, with few exceptions The sparks can be taken by a penknife held in hand ; sometimes they can be taken to the knuckle or finger-tip even when pressed against them.

7. Sparks can be got to pass between two totally uninsulated things, neither of which have any connection with the lightning conductor. For instance, let the conductor be thoroughly earthed in some outdoor and distant manner, and under favourable circumstances a bright short spark can be seen passing at every discharge between a gas tap and a water tap of my lecture table which happen to approach each other closely. Let the gas escape near these sparks and it ignites.

8. Sparks can be got between two thinly insulated electric-light wires if they lie close enough together, and if a storage battery be

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connected to them an arc will be started, destroying the insulation and burning the wires.

9. If at any distant place, or out of doors in daytime, the sparks are too feeble to be seen, disturbances can still be easily detected by means of a telephone, connecting one terminal to the thing—say, the roof of a shed or a wire fence—and holding the other end in one hand; or, of course, by connecting the two terminals to two different things, or to different parts of one thing.

10. Arrange Abel's fuses between gas and water pipes, between pieces of wire gauze and gas pipe, between hot water pipe and a bit of sheet metal, between the lightning conductor and a 6in. metal sphere on long glass stem, between two large insulated bodies, between the gas bracket of another room and an empty Leyden jar; in short, in almost any place, likely or unlikely. Then take a few strong discharges through the thick copper rod with end well earthed, and the fuses will pop off, some at one discharge, some at another. Very visible sparks can sometimes be seen passing into the fuses, if they be not closely connected, without exploding them. A certain energy of spark is necessary to ignite the composition, much more than is sufficient to excite the retina.

Lightning Protectors.

33. Now let me say a word about the possibility of protecting telegraph and other instruments from damage by lightning currents which may have entered the aerial lines.

There is, indeed, no guarantee that burying wires beneath the pavement, or even beneath water, will effectually secure them from lightning disturbance, as I have now fully illustrated, but certainly overhead wires are more exposed.

The ordinary and well-known form of lightning protecting arrangement is to attach a pair of plates, or a double set of points, or a pair of points in a vacuum, or some other small air space, as a shunt to the instrument or coil of wire to be protected. Here are arrangements of the kind. Now it is perfectly easy to see that the protection such things afford is of the most utterly imperfect kind.

Take a coil of tangled silk-covered wire, or any other coil that you don't mind damaging, and attach it as a shunt to one of these protectors. On discharging a jar through it, the insulation of the coil is pierced in heaps of places. Or one may use a short fine wire, and see it deflagrated by the branch discharge.

34. It may be said that my air space is too wide. Very well, then abolish it altogether. Bring the plates of your protector into direct metallic contact. By so doing the coil is indeed shunted out of the circuit, and if it were a telegraph instrument no signal could be given, for no appreciable fraction of the current takes that route; but with a Leyden-jar flash it is otherwise. Although the plates of the protector are in contact, soldered together if one pleases, and led up to by stout wire or rod, a branch flash still breaks through the insulation of our wire tangle or deflagrates our little bit of thin wire.

35. It will be said the joints are bad. Well, then, do without joints; take a stout rod of electrolytic copper bent in an arc, say, 2ft. long, and bridging it across with the wire tangle, discharge a jar round it. Still a portion takes the thin wire, even though it offer a path yards in length.

Take a straight bar of copper an inch thick, and arrange an invisibly fine Wollaston wire of greater length as a tapping circuit. Some of the discharge shall leave the bar, and spark across a minute air gap at each end, in order to make use of the hair-like platinum wire.

Go further still than this. Connect a coil of thin-covered wire *by one end only* to a wire conveying a discharge, standing the reel upon a block of paraffin or other good insulator, and connect the other end to any little thing of any capacity at all—say, a bullet lying on the block of paraffin; you can see sparkings through the insulation of the wire on the reel at every discharge.

These experiments render manifest the hopelessness of any simple shunt arrangement as a lightning protector.

36. The easiest mode of exhibiting the essentials of these experiments—one that can be tried by any one possessing a Leyden jar, a pair of discharging tongs, and a yard or two of fine silk-covered wire—is to hang a tangle of the wire loosely on to the tongs, not necessarily making any sort of good contact, and then use them to discharge a jar in the very ordinary way. Some of the flash will take the thin wire and will spark through the insulation at a number of points.

37. It may be very well objected to me that it is pretty useless if I only point out the imperfection of present methods and offer no suggestion as to a proper lightning protector. Well, this struck me, too, and the result is that I have devised and made what I think I may call an absolutely perfect protector—one into which great flashes may be sent, and yet the galvanometer or instrument intended to be protected shall not wink, nor shall the slightest palpable or visible disturbance be discernible, notwithstanding that complete metallic contact is maintained all the time and not a trace of the signalling or useful current wasted.

The thing seems so good that I am making it the subject of a patent, and you will therefore pardon me for saying no more about it just yet.

38. The next part of this Paper is largely controversial. I do not take much pleasure in this portion, and wish it were unnecessary. But it is a purely impersonal controversy; and so long as the old-fashioned views are in existence, one way of arriving at the truth is to try and thrash them out of existence. If there is any real vitality in them, the attack will fail. It will be well believed that I have no feeling of hostility to the Lightning-Rod Conference when my best scientific friend, Prof. Carey Foster, was one of its members. Had I been one myself, I no doubt should at that time have signed the very documents which now, in a few places, I criticise. Had I indeed so signed, I would abuse what I now see to be its erroneous portions with still more vigour than I now permit myself to employ.

(To be continued.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, May 10th.

Royal Institution.

9 p.m. Evening Discourse. "The Optical Properties of Oxygen and Ozone." By Prof. Dewar, M.A., F.R.S.

SATURDAY, May 11th.

Royal Institution.

3 p.m. Afternoon Lecture. "The Origin and Development of Opera in England (with Musical Illustrations). By Joseph Bennett.

Physical Society.

5 p.m. (i.) "On an Electrostatic Field, produced by Varying Magnetic Induction." (ii.) "On the Concentration of Electro-magnetic Waves by Large Cylindrical Lenses." By Prof. O. J. Lodge, D.Sc., F.R.S.

MONDAY, May 13th.

Society of Arts.

8 p.m. Cantor Lecture VI., 2. "Heat Engines other than Steam." By H. Graham Harris, M.I.C.E.

TUESDAY, May 14th.

Royal Institution.

3 p.m. Afternoon Lecture. "The Italian Renaissance Painters: Their Employments." By Jean Paul Richter, Ph.D.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Discussion on "The Treatment of Steel by Hydraulic Pressure, and the Plant Employed for the Purpose." By W. H. Greenwood, M.I.C.E.

Society of Arts.

8 p.m. Applied Art Section. "Venetian Glass." By Dr. Salviati.

WEDNESDAY, May 15th.

Royal Meteorological Society.

7 p.m. Ordinary Meeting. "Account of some Experiments made to Investigate the Connection between the Pressure and Velocity of the Wind." By W. H. Dines, B.A., F.R.Met.Soc. "On an Improved Method of Preparing Ozone Paper, and other forms of the Test, with Starch and Potassium Iodide." By C. H. Blackley, M.D., F.R.Met. Soc. "On the Climate of Akassa, Niger Territory." By Frank Russell, F.R.G.S.

Society of Arts.

8 p.m. Ordinary Meeting. "The Use of Spirit as an Agent in Prime Movers." By A. F. Yarrow.

THURSDAY, May 16th.

Royal Institution.

3 p.m. Afternoon Lecture. "Chemical Affinity." By Prof. Dewar, M.A., F.R.S.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting. Paper not decided on.

FRIDAY, May 17th.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 4, The Sanctuary, Westminster.

Royal Institution.

9 p.m. Evening Discourse. "Optical Torque." By Prof. S. P. Thompson, B.A., D.Sc.

SATURDAY, May 18th.

Royal Institution.

3 p.m. Afternoon Lecture. "The Origin and Development of Opera in England (with Musical Illustrations)." By Joseph Bennett.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 4 p.m.

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The Electrician.

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X.X., 523.—*Letters await you.*

THE LIGHTING OF LONDON.

With the conclusion of the Board of Trade's Inquiry into the lighting of London, it is probable that the chief impression left upon the minds of our readers is one almost of dismay at the extraordinary complexity and magnitude of the problem which now confronts them. Whilst there is every reason to feel confidence in a successful issue, yet at the present stage we cannot overlook the fact that the Legal, the Technical, and the Commercial aspects of the question have each their own doubts and their own difficulties, and each involve considerations which not unfrequently appear to be in conflict both amongst themselves and with each other. Some of the responsibility for the existing difficulties must rest with the authors of the Electric Lighting Act, whose provisions are already discovered to be in many points incomplete, ambiguous, or inapplicable. There can be no doubt that it is a grave defect in the Act not to have distinctly specified whether an Order is or is not to be regarded as conferring a

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monopoly within the scheduled district. In 1883 the Board seemed to take the view that a system of districting, and what is now described as "potential competition," was preferable to the actual existence of competing companies within one and the same area. With this view we are in general prepared to coincide; yet, on the other hand, the circumstances of different localities are so widely varied that we can well believe that occasions may arise when actual rather than "potential" competition will be distinctly for the public advantage. Since, however, the Act is admittedly inconclusive on this point, we do not see that the Board is under any necessity to pronounce a final or universally applicable decision either one way or the other. On the contrary, it would seem to be quite within its discretion to enforce a system of districting where such an arrangement would appear best suited to the locality, and none the less to permit a direct competition in neighbourhoods where the local conditions are of a different character.

Another proviso in which the Act is now seen to have been singularly deficient in foresight is that of the much controverted Purchase Clause. It seems strange that amidst all the strife and contention which has raged around this thorny question no one should have taken the trouble to inquire—until the London Electric Supply Company thought proper to furnish a concrete example—as to what should be done when the central station supplying current in a particular district happened to be situated in the domain of another local authority. The question now presented for decision amounts to this—whether at the end of forty-two years the Parish of Deptford is entitled, so far as this Act is concerned, to buy up plant capable of lighting the whole of London, and whether also the various Local Authorities to whom the Company in question may then chance to be supplying current are to content themselves with the questionable privilege of purchasing the local network of distributing mains. It is clear enough in practice that the system adopted by the London Company carries with it the entire abrogation of this section of the Act. But this certainly cannot for a moment be permitted to constitute a valid argument for refusing to sanction such a system. It would be a monstrous thing if the deficiencies and blunders of a legislative enactment were allowed to impose a veto upon the progress of engineering science, and to rule that no central station shall supply current beyond the limits of the Parish in which it may happen to be placed. And again, on the other hand, it must equally be admitted that the Local Authorities may justly consider it a grievance if their legitimate privileges are curtailed; and further, that competing companies may as reasonably complain if restrictions are imposed upon them from which others have succeeded in making their escape. The whole question affords a very pertinent illustration of the difficulties and absurdities which beset the application of doctrinaire legislation to a complex problem (ill-understood at best), whose conditions are in process of continual development with the advancement of science.

In yet another aspect of the problem we find ourselves confronted with a state of things little, if at all, contemplated in the Act, but in this instance the responsibility rests wholly with the Companies themselves. Possession, as we all know, is held to constitute nine-tenths of the law, and with one or two exceptions the Companies concerned have taken time by the forelock and have already gained a more or less precarious foothold within (or within reach of) the districts which they seek to light. The very fact that in this respect all are about equally guilty will tend somewhat to simplify the procedure of the Board. If one or two Companies alone had sinned the Inspector might conceivably have felt it his duty to uphold the stern majesty of the Law, and to enforce an awful warning upon all who might be tempted to the endeavour thus to force its hand. As matters stand he will possibly deem it sufficient to mark his appreciation of the correct and patient demeanour of the Notting Hill Company—which alone has done *absolutely* nothing—by granting everything it asks. Nevertheless, the question is not without its more serious aspect; and whatever may be the upshot of the London concessions, we take it that the Companies who work upon a wholesale scale will be ill advised if they attempt to pursue the same methods in many of the provincial towns. On the other hand, where local companies have been formed, and possess the assent of the Corporation, there would seem in general to be no sufficient reason why they should not push on (at least with the Central Station work) pending their applications to the Board.

Turning to the financial aspect of affairs, we have taken the opportunity to tabulate below some of the chief financial details which were elicited in evidence or have since been furnished us. It will be seen that the information solely relates to the

THE LONDON ELECTRIC LIGHTING COMPANIES.

Name of Company.	Registered Office.	Authorised Capital.	Paid-up Capital.	Expenditure incurred or Capital Allocated.	Remarks.
		£	£	£	
Chelsea Electricity Supply Company.	37, Sloane-square, S.W.	100,500	33,085	30,000	It is proposed to increase the capital to £205,000.
Electrical Power Storage Company.	4, Great Winchester-street, E.C.	200,000	149,500	—	It is proposed to raise £60,000.
House-to-House Electric Light Supply Company.	117, Bishopsgate-street, E.C.	350,000	41,600	—	—
Kensington & Knightsbridge Electric Lighting Company.	High-street, Kensington, W.	250,000	37,240	65,000	It is proposed to call up shortly an additional £30,000.
London Electric Supply Corporation.	3, Adelphi-terrace, W.C.	1,250,000 (£800,000 sub.)	585,000	535,000	—
Metropolitan Electric Supply Company.	Winchester House, Old Broad-street, E.C.	500,000 (fully subscribed.)	152,732	380,000	First issue of capital.
Notting Hill Electric Lighting Co.	9, Austin Friars, E.C.	100,000	--	—	No public issue has been made at present.
Pilsen-Joel and General Electric Light Co. (now Gwynne-Pilsen Electric Co.)	4, Stanhope-street, Euston-road	200,000	91,000	25,000	—
St. James' and Pall Mall Electric Light Company.	Mason's Yard, Duke-street, St. James', W.	100,000	26,000	44,000	£50,000 debenture shares have been created and placed.
Westminster Electric Supply Corporation.	28 Victoria-street, W.	100,000	8,000	50,748	—

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nine Companies who are now making application for Provisional Orders for the lighting of the Metropolis. The total authorised capital of these nine Companies is no less than £2,950,000, of which £1,033,157 has been already paid up. Two of the Companies, however—the House-to-House and the Electrical Power Storage, who possess between them a paid-up capital of £190,000—have work in hand besides the lighting of London. If a deduction be made on this account it will be seen that somewhere between £700,000 and £800,000 is actually invested at the present moment in central station work within the Metropolitan area. But this figure scarcely represents the true state of the case, for out of the authorised capital of £2,950,000 a sum considerably exceeding one million sterling has already been expended or allocated to specific work. The figures cannot at present be more precisely given, since, for reasons which will be obvious, some of the details are unattainable. The facts stated will, however, be sufficient to emphasise the assertion that capitalists have ceased to regard the electric light as a hopeless venture, and are now prepared to find funds for schemes of asound and well-considered character.

ELECTRIC LIGHTING AT THE MELBOURNE CENTENNIAL EXHIBITION.

At a time when we in this northern hemisphere are preparing to open our summer Exhibitions we have received the account of the close of the very successful Exhibition at Melbourne in Victoria, and, as part of its great success has been unquestionably due to the admirable way in which the electric lighting of it was carried out, we gladly print the account of it which we have received from the secretary of the Australasian Electric Light, Power and Storage Company. The commercial and technical details given are very full, and will be of value to our readers :—

The very short time allowed for the execution of the contract added materially to the contractor's difficulties and expenses ; but notwithstanding all obstacles the lights were in operation on the opening night and were well maintained until the close of the Exhibition, the number being constantly increased as fresh demands were made on the installation. The Exhibition was formally opened on the 1st August, but the contract was not signed until March 27, and the special annexe for the engines and dynamos was not ready until long after the date exp cted; while the month of July was more than half over before the painting of the inside was finished sufficiently to allow the cables and leads to be joined up to the dynamos and switchboard.

When the lighting of the Exhibition was first discussed, the question arose as to whether gas or electric light should be adopted. As concerned the picture galleries, there could be of course no question at all, as the sole condition on which many of the pictures were allowed to be exhibited at night was that they were not to be exposed to the fumes of gas.

Mr. K. L. Murray, of the Railway Department, who had extensive experience of lighting by gas and by electricity, was requested by the Commissioners to report on the matter, and his estimate, although made in November, 1887, was, as the figures which we give will show, wonderfully near the amount of lighting that was actually required. He estimated for 950 arc lights of 1,000 candle-power each and for about 50,000 candle-power other lighting, making a total of about 1,000,000 candle-power.

In Mr. Murray's report he stated that he considered it fair to compare gas and electric lighting at per candle-power, and doubtless many good reasons can be advanced for taking this as a fair ratio of comparison in a place like an Exhibition, and for the following reasons :—Firstly, as regards the portion lighted by arc lamps, the experience gained in the best lighted modern Exhibitions proves that not less than one candle-power must be allowed for each 1 to 1½ square feet of floor surface if the building is to appear bright, cheerful, and attractive at night ; or, in other words, that one must allow from ·66 to 1 candle-power for every square foot of floor space. This proportion was confirmed by experience at the Adelaide Exhibition, at which it was found that although 1 candle-power per 1·44 square feet gave a good light when the space was open and the colouring of the locality light, yet the same amount of candle-power produced but a gloomy effect among crowded show-cases and where the surroundings were of a dark tone. In adopting the above figure it must distinctly be borne in mind that although 1 candle-power per square foot of floor surface, or even more, may be provided by the installation, it by no means follows that there will be 1 candle-power of light per square foot *on the floor* of a building, as much of the light goes sideways and upwards.

Mr. Murray's estimate assumed the use of burners consuming 5 cubic feet of gas per hour with gas at 5s. 9d. per 1,000ft., and that each of them would give 20 candle-power. Only best gas and Argand burners would yield such an average, whereas in the Centennial Exhibition the bat's-wing or fish-tail burners must have been employed. Gas is, however, 5s. 4d. per 1,000ft. in Melbourne now, and, although it was dearer when the Exhibition started, it may be taken for granted that an average of 16 candle-power for a 5ft. burner with Melbourne gas is a liberal allowance even when the pipes keep clear, which rarely happens for any length of time. Now the total area to be illuminated in this case by arc lamps was 1,142,821 square feet, and to light this area 915 such lamps were used with actual illuminating power of 924,000 candles ; consequently the average area illuminated by each lamp was 1249·9 square feet of floor space, or ·808 candle-power per square foot.

To give the same amount of light by gas would have required about 58,000 No. 5 burners with their numerous adjuncts, which would consume 290,000 cubic feet of gas per hour at 5s. 4d. per 1,000ft., or at a cost of about £78 per hour. The expense of fitting up this mode of lighting would have been heavy ; but against that may be set the cost of the special building erected for the electric dynamos, engines, &c. The accounts are not yet closed, but the latest available printed figures reveal that the cost of the whole of the installation plant, including incandescence dynamos and all accessories, has been £60,000. As the special building is set off against gas-pipes and fittings which would afterwards be almost valueless, the whole of the plant is saleable ; but allowing 50 per cent. for depreciation and other contingencies, it is found that the use of the electric plant has necessitated an expenditure of £30,000, exclusive of six months' interest at 5 per cent., to which must be added the cost of 26 weeks of working. The correctness of the figures cannot absolutely be vouched for, but an amount of £300 it is believed will give a little over the actual cost of the fuel, wages, carbons, &c., for arc lighting.

We thus have the following results :—

Net cost of plant	£30,750
Cost of working for 26 weeks at £300 per week	7,800
Actual cost of electric arc lighting	£38,550

In these figures the arc lighting is considerably handicapped by including the cost of the incandescence plant, which means engines, dynamos, and lamps nightly supplying 44,112 candle-power = 2,757 other No. 5 gas burners in situations where gas would be intolerable.

There were 160 nights of lighting (783½ hours) ; consequently the nightly average was 4·89 hours, which, at £78 per hour, gives £331 per night, or £53,429 for the term of the Exhibition, as the gas bill for those portions lighted by arc light, showing a clear saving of £15,000 in favour of the electric light. The volume of heat which so many gas jets would have emitted would have been enormous, and both the picture galleries and the concert hall would have been intolerably close if gas had been used.

Mr. K. L. Murray drew up the specifications, and to the constant and careful supervision by himself, and by his assistant, Mr. W. Stone, much of the success of the scheme is due.

Tenders were originally put in by the Australian Electric Company, Melbourne, as agents for the "Australasian Electric Light, Power and Storage Company, London," carrying on business in these Colonies.

Captain F. C. Rowan, General Manager of the Australasian Company, assisted by Mr. R. E. Fletcher as Chief Engineer, prepared the estimates and ordered the plant. The latter was nearly all supplied by the Anglo-American Brush Corporation, and all parties concerned in the enterprise deserve great praise for the rapidity and completeness with which this, the largest and most important electric light installation yet carried out, was placed in good working order and successfully maintained, despite the unlucky accident to the R.M.S. "Garonne" while on her way out with a large portion of the plant, which compelled the contractors to work for some time, both night and day, and involved a serious charge for overtime.

The following statistics in this connection will be of interest :—

Total area of buildings lighted by arc lamps	1,142,821	sq. ft.
Total area of buildings lighted by incandescent lamps	163,906	,,
Number of Brush arc lamps used in building	908	937
Number of Brush arc lamps used outside of building	29	
Number of Brockie-Pell arc lamps used	5	
Total number of arc lamps	942	
Number of Edison-Swan incandescence lamps, 16 candle-power	1,882	
Number of Sunbeam incandescence lamps of 200, 300, 400, 500, and 600 candle-power	27	
Total candle-power of arc lamps	953,000	
Total candle-power of incandescence lamps	44,112	
Average area of floor space per arc lamp (915 lamps) inside lighting	1249·9	sq. ft.

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Average area of floor space per incandescence lamp	85·9 sq. ft.
Candle-power per square foot of floor space (arc lights) inside lighting	·808 c.-p
Candle-power per square foot of floor space (incandescence) inside lighting	·268 „
Total number of hours lighting	783½ hrs.
Average number of hours per night (160 nights)	4·89 „
Total number of watts used by arc lamps, inside lighting —447,696. Ditto, outside lighting—14,123	461,819
Watts per square foot of floor space (inside lighting) ...	391
Total number of watts used by incandescence lamps —1882—16 candle-power 64 watts = 120,448 watts, 27 Sunbeam = 24,295 watts	144,743
Watts per square foot of floor space	383
Area of concert hall	19,000 sq. ft.
Candle-power of incandescence lamps in Concert Hall ...	·578 c.-p. per „
Circuits (Arc)—Number of arc circuits	41
Average length of circuits	1·22 miles
Total amount of cable used	50 „
Incandescence—Number of incandescence circuits.....	7
Amount of main cable used	3m. 981yds.
Amount of Brush mains and leads to arc lamps	10 miles
Total amount of cable and wires used for arc and incandescence circuits	63m. 981yds.
Total weight of copper in above	17tn. 11cwt. 1qr. 19lb.
Dynamos (Arc)—1 No. 8 L Brush dynamo, 55 lamps ...	27,500 watts
40 No. 7 L Brush dynamos, 24 lamps = 12,000 × 40.....	480,000 „
1 No. 6 Brush dynamo, 10 lamps	5,000 „
Total capacity or out-put available from arc dynamos (=1,025 Brush lamps)	515,000 „
Incandescence—7 No. E 2 Victoria dynamos, 110 volts, 210 amperes	23,100 „
Total capacity of above machines in 16 candle-power 64-watts lamps	2,526 lamps
Belting—Lancashire patent woven belt	3,452 feet

Shafting—Total length, 203 feet.
Diameter, 7½ to 6¼ inches.
Supported on 33 iron pedestals.
Divided into three sections, with clutch couplings, but always run connected as one length.
Fitted with 52 pairs of cast-iron pulleys (one fast and one loose of each pair), for driving the arc and incandescence dynamos.
Normal speed of shafting, 192 revolutions per minute.

ENGINES.—Three pairs of horizontal high-pressure engines of Marshall and Sons' type, with automatic expansion gear.

Each pair fitted with a cast-iron fly-wheel 12ft. diameter, weighing 19 tons, and having 13 grooves on face for 13 = 4½in. manilla ropes, 12 ropes used for driving on to counter-shaft.

Diameter of cylinders, 20in.

Length of stroke, 40in.

Normal speed, 60 revolutions per minute, but worked up to 80 revolutions.

Normal horse-power of each pair, 500 horse-power.

BOILERS.—Twelve boilers of the Cornish multitubular type 16ft. 9in. in length by 5ft. 9in. in diameter, furnace tubes 10ft. 10in. in length by 3ft. 3in. in diameter, and 148 tubes 2in. outside diameter and 5ft. 11in. in length.

Each boiler provided with cylindrical steam chamber on top, and the whole covered with wrought-iron casing, forming a portion of the flues, and acting as a super-heater for the steam.

All boilers fitted with double safety valves of the Ramsbottom type, 3in. diameter, and the usual gauge-glasses, blow-off cocks, &c., and rest in cast-iron saddles; the lower and unprotected portions of the boilers are covered with a non-conducting heat composition. The boilers are arranged in two groups of eight and four, and are in separate houses. They are all connected to one common steam main, each boiler being provided with a steam stop-valve, to disconnect from the main if required.

Working pressure, 120lb. per square inch.

Six-inch Blake's donkey-pumps and 6-in. Gresham's patent improved Gifford's injectors supplied the water to the boilers, after passing the water through 6 feed-water heaters, which raised its temperature to 170 and 180 deg. Fah.

Three wrought-iron smoke-stacks, 3ft. 9in. diameter, carried away the smoke, of which, however, there was very little, as the fuel consisted of coke with a very small quantity of coal mixed with it.

Boiler-houses, engine and dynamo-room were all under one roof, the boiler-houses being separated from the engine and dynamo room by brick walls.

Total length of dynamo-room, 221ft.

Total width of dynamo-room, 142ft. 6in., less 47ft. 6in. occupied by engines and boilers.

Arrangements of Dynamos and Circuits.—The dynamos were arranged in two parallel rows on each side of the counter-shafting, which was in the centre of the room.

The arc dynamos were connected to a switch-board of simple construction, to which also all the ends of the various lamp circuits were connected. By this arrangement any dynamo could be put on to any lamp circuit as desired.

The lamp circuits were arranged so that in every court in the vast building the lamps lighting a particular court were supplied with current from separate dynamos, which prevented the possibility of any part of the building being left in darkness should any mishap occur with the machinery.

The incandescence dynamos were connected to a very elaborate and handsome switch-board, by means of which all the dynamos could be joined up in parallel.

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

SECTION III.—MAGNETIC FIELDS OF COILS AND SOLENOIDS.

(*Continued from page 711.*)

Let us now apply this to the numerical example given above. The length of R will be seen to be the square root of the sum of the squares of the mean radius and length of the solenoid, which are two and six centimetres respectively. Hence

$$R = \sqrt{4+36} = 6{\cdot}32 \text{ centimetres.}$$

The current is 3 amperes (or ·3 C.-G.-S. units), and the number of turns of wire 200; therefore the field at either end of this solenoid is equal to

$$\frac{2 \times 3{\cdot}1416 \times {\cdot}3 \times 200}{6{\cdot}32} = \frac{377}{6{\cdot}32} = 59{\cdot}6 \text{ C.-G.-S. units.}$$

Now suppose we take a solenoid (Fig 150) exactly double the length of the above, but in all other respects the same, that is having the same depth of winding and the same

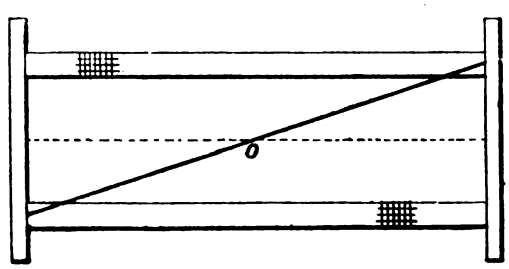

FIG. 150.

current. Evidently the field at the point O, taken now at the centre, will be twice that at the end of the former solenoid, and therefore we can write it down at once as

$$4\pi C_1 \times \frac{l}{R} \text{ C.-G.-S. units.}$$

But l is now only half the length of this solenoid, and therefore it is advisable to multiply both l and R by 2 (which does not alter their ratio). Now the value 2 R is equal to the line connecting opposite corners of the solenoid (Fig. 150), which we will distinguish by calling it the diagonal (D). And instead of writing $2l$ for the length of the present solenoid we shall write it l, keeping this letter to represent the length of solenoid whatever it may be. Therefore the field at the centre becomes

$$4\pi C_1 \times \frac{l}{D} \text{ C.-G.-S. units.}$$

Now let C^1 (the current per unit length) be expressed in terms of C (the current passing through the wire). It will be understood that the current per unit length of coil is the same value as before, and is expressed by the total current flowing round the bobbin (Cn) divided by l, n being the number of turns and l the length of the present solenoid. Cancelling out l the field at O becomes

$$\frac{4\pi Cn}{D} \text{ C.-G.-S. units.}$$

This is applicable to any dimensions of solenoid, and gives the field produced at the central point on the axis where it is most frequently required to be known.

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We have now the means of determining the strength of field at either end of a solenoid and at its centre on the axis. It will now be understood that taking *any* size solenoid whatever, and denoting by the letters R and D the two lines drawn and so marked in the figure (Fig. 151), that the field at either end on the axis is equal to

$$\frac{2\pi C n}{R} \text{ C.-G.-S. units.}$$

and that at the centre is

$$\frac{4\pi C n}{D} \text{ C.-G.-S. units.}$$

It is worthy of note that when the solenoid is very long R becomes practically equal to D, while if the solenoid is very short, more like a galvanometer coil, R is practically equal to half of D.

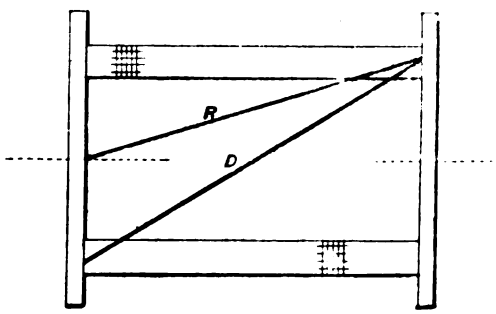

Fig. 151.

Applying the latter expression to find the field at the centre of the solenoid whose dimensions are given above (Fig. 148), we find that the numerator is twice the previously calculated amount, and is therefore equal to 754. The length of D is the square root of the sum of the squares of the mean diameter

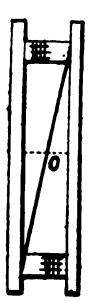

Fig. 152

and length of solenoid, which are 4 and 6 centimetres respectively. Hence

$$D = \sqrt{16+36} = 7{\cdot}21 \text{ centimetres,}$$

and the field at the centre is therefore equal to

$$\frac{754}{7{\cdot}21} = 104{\cdot}5 \text{ C.-G.-S. units.}$$

It will easily be seen that the *longer* the solenoid the nearer does D become equal to l, and that for a long narrow solenoid we may consider it the same as l without any appreciable error. The field at the centre of such a solenoid is then—

$$\frac{4\pi C n}{l} \text{ C.-G.-S. units,}$$

to which expression reference has already been made (paras. 130 and 133). Again, the shorter the length of the solenoid the more it approaches the shape of a current ring (Fig. 152), and we should therefore expect the field at the centre to become very nearly equal to that due to a thin ring of current. This is so, for the diagonal line is very nearly the same as the mean diameter of the coil, and does become exactly equal to it when the coil is made shorter and shorter till it forms a narrow ring. When such is the case, instead of the diagonal D in the above expression we can put the mean diameter of the coil or twice the mean radius ($2r$). Cancelling out the 2, the field at the centre becomes

$$\frac{2\pi C n}{r} \text{ C.-G.-S. units,}$$

which is the same as previously derived for a narrow ring-shaped coil of n turns (par. 145).

The next point to consider is the strength of field at *any* point on the axis either inside or outside the solenoid, and this case will necessarily include those already taken. The expressions, however, which have been derived above for finding the field at the centre and at either end of a solenoid will be found useful not only as steps leading up to the most general case, but as easy expressions to deal with, showing also at a glance the relation between the field at these points and the diameter, length, and depth of winding of a solenoid.

(To be continued.)

THE BOARD OF TRADE INQUIRY ON THE LONDON ELECTRIC LIGHTING PROVISIONAL ORDERS.

This Inquiry was concluded on Wednesday, 1st inst. Our last report of the proceedings was brought up to the end of the previous Monday. The following gentlemen represented the various parties concerned :—

Mr. Pember, Q.C., Mr. A. K. Loyd, and Mr. J. C. Graham appeared for the London Electric Supply Corporation ; Mr. C. A. Cripps for the Metropolitan Electric Supply Company ; Mr. Moulton, Q.C., and Mr. R. S. Wright for the Chelsea Electricity Supply Company ; Mr. Muirhead for the St. James's and Pall Mall Electric Light Company ; Mr. Roger W. Wallace for the Notting Hill Electric Light Company, for the Kensington and Knightsbridge Electric Lighting Company, and for the Westminster Electri-Supply Corporation ; Mr. Moulton, Q.C., and Dr. Hunter, M.P., for the Electrical Power Storage Company ; Mr. G. Prior Goldney (the City Remembrancer) for the City of London ; Mr. T. Percy Gunyon (engineer) and two members of the Council for the London County Council ; Mr. C. A. Cripps and Mr. F. M. Jenkins for the Strand District Board of Works ; Mr. Hopwood (solicitor) for the Holborn District Board of Works ; Mr. E. Bayley (clerk) and Mr. G. W. Thompson (surveyor) for the St. Olave's District Board of Works ; Mr. James Spencer for the Greenwich District Board of Works ; Mr. J. H. Horton for the Paddington Vestry ; Mr. Hitchins for the St. George's (Hanover-square) Vestry ; Mr. Wilkins (clerk) and Mr. W. Jenkins (chairman of the Lighting Committee) for the St. James's (Westminster) Vestry ; Mr. Webster Murnane (clerk) for the St. Martin's-in-the-Fields Vestry ; Mr. T. Eccleston Gibb (clerk), and Prof. Robinson, C.E., for the St. Pancras Vestry ; Mr. Cripps and Mr. Greenwell for the Marylebone Vestry ; Mr. H. J. Smith (clerk) for the Lambeth Vestry ; Mr. Harrison (solicitor) for the Bermondsey Vestry ; Mr. E. Moore (solicitor) for the Great Eastern Railway Company ; Messrs. Payne, Son and Pollock (solicitors) for the North London Railway Company.

Tuesday, April 30.

Mr. C. A. CRIPPS, continuing his speech on behalf of the Metropolitan Company, said there were only certain preamble objections, if he might so call them, to his Mid-London Order. They came from St. Margaret's and St. John's, Westminster, from the City, and to a certain extent from the St. Giles's District Board of Works. With those exceptions there was no opposition from any local authority in respect of any of the orders asked for under the Mid-London Order. Now the attitude taken up by the St. Margaret's and St. John's, Westminster, is this : they say "We think all Provisional Orders should be refused, and that the local authority should be allowed another year to consider the whole question." As no evidence was given on behalf of the Vestry he did not know why objection was taken, nor did he know whether he could deal with that objection in matters of detail or drafting. But the Vestry had stated, and stated specifically, that if any Order is granted they are in favour of competition ; as, therefore, the competitors in the parish were the London Company, the Metropolitan Company, and Mr. Wallace's Company, he could only plead in reference to this local authority that if any Order is granted it should assuredly be given, amongst others, to the Metropolitan Company. With regard to the City objection there can be no doubt that the City is placed on precisely the same basis as all other local authorities with powers in the schedule to the Act of 1882. It is quite right, no doubt, that the wishes of the City should be considered and consulted, but whatever their powers may be, or whatever the powers of the Commissioners of Sewers may be under the Act of 1848, it is quite clear as regards electric lighting they are on the same basis as all other local authorities.

Mr. RUSSELL GRIFFITHS : That is not so. They have greater powers.

Mr. C. A. CRIPPS said his argument was they were under the Electric Lighting Acts. As regards the objection of the City to the system, he

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would say without hesitation that every criticism which had been advanced by Mr. Russell Griffiths was not against the Metropolitan but against the London; there was not one suggestion of electrical difficulty brought forward which was applicable to the Metropolitan Company. He would submit that, having modified the 21 years back to the 42 years, and taking Mr. Preece's own opinion that the converter system with central stations is the best for the City, and taking, further, that the Metropolitan were willing to go into the City, not on the competition system but on the districting system, there is no difficulty between the Metropolitan Company and the City which can keep them apart. He believed negotiations had already begun, and he hoped they would soon be consummated, to the immense advantage of the City and to the advantage also, no doubt, of the Metropolitan Company, who had laid out an immense amount of money and arranged for stations so as to deal with the City as well as with other places in respect of which they ask for Orders. He now came to what was no doubt a very controversial matter—the Strand agreement. It had been attacked by two bodies—the London Company and the St. Giles's District Board of Works; but it had been attacked on entirely inconsistent lines. Mr. Pember, for the London Company, urged that it was an improper agreement, an agreement which could not be sanctioned by the Board of Trade, and that it was contrary to the policy of Parliament as shown in the Electric Lighting Acts. Mr. Jones, for the St. Giles's District, took an entirely different attitude. He said that it was a very proper thing for the local authority and the company to come to these terms, that they were very proper and admirable ones; but he said, "If you give these terms to the Strand why do not you give similar terms to the local authority which I represent." There had been a suggestion of unfair advantage shown to the Metropolitan Company. Now the evidence came to this: That originally a letter was sent in identically the same terms to the London and Metropolitan companies; that that was followed by negotiations with both Companies; that as regards the London Company the negotiations came to nothing; that as regards the Metropolitan Company the negotiations ultimately ended in the agreement which was now before the Inquiry, and the only possible suggestion of unfairness of any kind was that the Strand Board of Works did not disclose to the London Company the terms on which they were negotiating with the Metropolitan Company. He would say without hesitation that it would have been an improper thing for the Strand Board of Works to have done so. The Metropolitan did not ask to see the London negotiations, nor were they disclosed to them. Where, then, was the unfair advantage? Going through the paragraphs of the agreement, the first deals with appropriation of stations. What was there contrary to any proper negotiation as between a local authority and the company that there should not be an appropriation of stations for the purpose of the particular district? The second paragraph is with regard to the distributing of electric lines, which he thought was a very proper thing for the local authority to determine. The third is "distributing boxes," and he thought it was a proper thing for the District Board to decide where they should be put. Now the obligation to supply is next. The effect there is that somewhat better terms are given to the consumer than under the ordinary forms of Provisional Orders—what was there immoral or wrong in that? Then the "normal pressure" clause. The alteration there brings the normal pressure within the cognisance of the Board of Trade and is fixed by penalties, and there could not be any question that that was a matter properly dealt with by the agreement. The sixth is the "additional facility" clause. That is nothing more than, whereas under the old Orders they had Schedule A and Schedule B, here after a certain time other streets and other districts are to have the same facilities as the streets marked green upon the plan. The seventh is interference with the surface of streets; it was a matter which had been fought over and over again in Parliament, and been decided sometimes one way and sometimes the other. He could give fifty precedents for it. Then there remained the last—the question of price. To show the *bonâ fides* as to that he would say they had taken the price in the Order. As to revision of prices, he maintained that it was a perfectly proper thing that in an agreement extending over forty-two years there should be revision of price. There were many questions still to be worked out with regard to the systems of lighting and with regard to cost, and it was a perfectly proper thing that from time to time there should be a revision of the price. In the early Gas Acts there was revision of price; he knew it had been superseded by the sliding scale, but he said the sliding scale in itself was a revision of prices—the very essence of the sliding scale was a revision of prices—and it had been going on in the Metropolis to the very great advantage of both the consumers and the companies. How his friend could say in the face of the sliding scale doctrine that the revision of prices is improper he was at a loss to understand. The Inspector clause, it appeared to him, in no way infringed upon the proper authority of the Board of Trade. Then "additional mains to be laid in the street, and the manner in which requisition is to be made, and the provisions for requisition," were, it appeared to him, purely domestic matters, to be settled between the local authority and company, whatever it may be. Then "Provision for requisition by the District Board"—well, that gives the District Board favourable terms—that was what that came to. Then there comes "damages for default," which his learned friend suggests are heavy. Well, let them be heavy; let them be such as the London Company could not face. The Metropolitan did not fear. The supply clause is a mere matter for the consumer. The maximum current clause is taken out because it is absolutely the same as in the Provisional Order—there is no difference between the two. Then the question of supply of electricity to public lamps—that is certainly a matter which comes within the cognisance of the local authority. With regard to the clause as to termination of agreement, the effect of that is that if the Metropolitan do not do their duty it is brought to the notice of some independent gentlemen appointed by the London County Council, and if they decide that they had not done their duty then they would lose the benefit of their Order.

Major MARINDIN: What I understand is simply this, that under the Order the power of revocation is in the hands of the Board of Trade, and here it is in the hands of the London County Council.

Mr. PEMBER: They have got two chances of being turned out—one if the Board of Trade thinks they ought to be turned out, and one if the District Board independently thinks they ought to be turned out.

Mr. CRIPPS said the District Board act not directly but through the medium of an arbitrator appointed by the County Council. He submitted with great confidence that there was no inconsistency in the two provisions. The only other point he thought he need refer to was with reference to the appointment of an arbitrator at the termination of the agreement. He was anxious that it should be left to the Board of Trade and not to the County Council, but it was a matter on which no doubt both parties would be very much influenced by any statement that the Inspector might make with regard to the Board of Trade. Now, leaving the Strand agreement, he would deal shortly with a matter which affected all the Orders, and that was the clause which Mr. Moulton suggested on behalf of the telephone companies. Mr. Moulton's argument was this: you are creating a nuisance, and being parties creating a nuisance you must for all time protect any one who may be affected by the nuisance which you are creating, and therefore not only as regards existing telephone wires but as regards all telephone wires which may be laid down in the future you must come under terms to provide against all possible or contingent damage. Now he (Mr. Cripps) said as a matter of principle that argument was quite wrong—it was a monstrous assumption. The right principle was this—and it was a principle that had been adopted over and over again—that where a telephone company have laid down their system and are in occupation they have a right to be protected against any second company seeking to come in. Where they are first in possession they are entitled to the rights they have got, and if we interfere with those rights we ought to give them full compensation. Where we are first in possession we are entitled to be protected in exactly the same way. Mr. Cripps said he would now deal with the question of the comparison of systems. If the alternating current could not be used for motors that was an advantage for the purposes of this Inquiry, as all the company's capital must then be devoted to lighting; but he said that motors could be used, and they had their hands free to use the direct system for motors.

Major MARINDIN: I do not agree with you that we are dealing with lighting only. I cannot take that.

Mr. C. A. CRIPPS said that scientific gentlemen were of opinion that the alternating system could be used for motors. In the system of the London Company he contended that there were numerous difficulties which Mr. Ferranti had not disclosed how he intended to overcome. The London Company had attacked the Metropolitan system, and, therefore, he must call attention to the weak points in their harness. They had not had a single expert to back up Mr. Ferranti. He thought there was an overwhelming preponderance of the best scientific opinion in favour of the alternating system as proposed by the Metropolitan Company.

Mr. PEMBER said that the Metropolitan and the London cases were undoubtedly the most important of the Inquiry. It was the unpledged companies who desired to shut out the competition of the London Company. As to compulsory areas, they were admirable things to prevent a company with only problematical chances of getting its capital grabbing a district and keeping others out. The London would spend the whole of the £800,000, or more if wanted, to supply the districts it had undertaken to serve. If at the end of the 42 years the local authority bought up the undertaking without the Deptford Station, the Deptford plant would remain on the hands of the company, but he was not at all afraid of such a contingency. The Deptford Station would avoid the addition of 1,000 tons of coal cartage a day in the Metropolis, and that enormous cartage meant serious addition to the wear of the roads. Then as to the repair of batteries at the stations proposed in London, that either meant additional cartage and traffic or noise at the stations during repair, so that absolute quiet would not reign even at the Storage Company's proposed stations. A moderate-sized room, on the other hand, would suffice for the distributing stations of the London company. That was all the London company intended to do in the way of setting up buildings in London. Mr. Moulton had said that there would be "darkness if one gigantic dynamo went wrong." How could there be when there were two? The reduction of the voltage from 10,000 to 2,400 was not a question of experiment, but was actually done at the present time. Now their system, apparently so complete and simple, was by far the newest and the greatest stride taken in practical electricity for many years. Gentlemen had been loud-tongued on short-circuiting and its consequences, the difficulties of jointing on the voltage of 10,000, on leakage from primary and secondary mains, the injurious effects of transformers on the life of lamps, and the absence of a motor for the alternating current—this was a long list of objections which he would deal with on the next day.

Wednesday, May 1.

Mr. PEMBER, resuming his address on behalf of the London Electric Supply Corporation, commenced by stating that he had been told that Major Marindin had stated at Brighton the other day that the Board of Trade had determined not to adopt the new unit.

Major MARINDIN said that that was so.

Mr. PEMBER said that oddly enough in a journal which had been shown to him it was stated that the Board of Trade had made up their minds to adopt the new unit.

Major MARINDIN said he was informed by the Board of Trade that they had decided to retain their own unit and not to adopt the new unit.

Mr. PEMBER said no doubt Major Marindin was better informed than the journalist in question; but he urged that they should adopt the larger unit of 10,000 amperes, as in the schedule of the London Company, rather than that of 1,000 amperes—for this reason, that with the price at 7½d., as at present charged at the Grosvenor Gallery, the smallest reduction which they

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could make in the charge would be ¼d., that being the smallest coin of the realm, and that would represent a reduction of 3 per cent., whereas in the case of a gas company, with the unit of 1,000 cubic feet, and a charge at 3s. 2d., the reduction was not of such a serious consequence. He would now proceed to deal with the objections which had been raised to what, *primâ facie*, seemed so admirable a system, namely, that of keeping the manufacturer outside London, and bringing the article wanted along trunk mains into town, and there, by small distributing stations, and without any moving machinery at all, distributing it amongst the various customers. It was impossible to conceive any simpler method, or, *primâ facie*, a better system for a great city like London. The objections that had been raised constituted every objection which hostility or self-interest or ingenuity could raise. The first objection was under the head of short-circuiting, which of course was connected with the joint. But Mr. Ferranti was not at all afraid of that, for his mains had been tried at 1,000,000 volts, and although that was not proof positive that the joint would stand the requisite test, yet that gave a margin of 100 to 1 for the pressure of 10,000 volts at which the electricity would pass. But experiments had been made from day to day while the Inquiry had been going on, and the Board of Trade would be informed that Mr. Ferranti's joints had been tested on the previous day only and found to stand a pressure of 650,000 volts.

Captain CARDEW: Many?

Mr. PEMBER: One joint. No doubt Captain Cardew would satisfy himself on the point, but he felt he would not be justified in withholding the information, although it was not strictly evidence. Dealing with Mr. Preece's evidence, he said that gentleman was called against him by the City, but they could hardly have known what Mr. Preece's opinions really were. When asked if the proposal of the London Company to supply from Deptford was a reasonable proposal he might have said "No;" but he did not say so, but merely that it was a gigantic experiment, and simply a question of pounds, shillings, and pence. And even on the commercial point he was not against the system of the London Company, though he was certainly in favour of the alternating system with the transformer. His objection was to the connection between London and Deptford by means of their mains, but everything else he admitted was perfectly workable. His objection related simply and solely to the way in which the company brought their mains up to London and the question of insulation and earthing, and when requested to formulate his objection he said that the difficulties he anticipated were difficulties of insulation of joints and of disturbance of the telegraphs and telephones. The company were willing to meet the objections of the Post Office and the question of safety to the public, and experiments were going on for that purpose. But the most important admission was that a cable could be made which should carry the main from Deptford to London, which would get rid of the Post Office objections and yet ensure the safety of the public. That, he thought, was absolutely conclusive. He did not wish it to be imagined that he was vain enough to wish to triumph over Mr. Preece, for if that gentleman had not felt what he said in the unqualified way in which he said it he would have thrown him (Mr. Pember) on his back in two minutes, and Mr. Preece was not a man whom he would cross-examine, in the hostile sense of the word, in such an inquiry as the present, but he insisted that the ultimate result of his evidence was uncommonly in favour of the London Company. Dr. Hopkinson, dealing with the question of electrostatic induction, said there would be no difficulty with regard to telegraph and telephone wires if if they were properly arranged; that he would not contemplate any fresh arrangement of those wires, but that he would contemplate a proper arrangement of the electrical conductors, and it would be quite unnecessary to disturb the telegraphs and telephones in any way whatever. Sir William Thomson said the same thing; he had no doubt that the difficulties could be got over by proper insulation, and that he did not anticipate there would be any trouble with the telephone companies from the carrying out of the London system. Referring to the question of short circuiting, and to the probabilities of a flare-up resulting from a break-down, he said a terrible story had been told by Mr. Crompton of the destruction of half-a-dozen cables and copper flying about in all directions, and that he had had the misfortune to be present when such accidents happened. That was the story of Mr. Crompton in brief, and was very high-flown in the matter of language and very solemn in the matter of tone; but on cross-examination he was bound to admit that it might have been the fault of the fuse, and that Mr. Ferranti would no doubt design a proper fuse. The learned counsel contended that with a proper fuse such results could not happen, as long before they could take place the fuse would be volatilised. Mr. Moulton had been absolutely silent in his summing-up, notwithstanding his elaborate cross-examination of Mr. Ferranti and his examination of Mr. Crompton upon this point, with the exception of what he would call, following Mr. Moulton's own metaphor, a little flare-up at the end which did not take five minutes. Referring to the question of the stoppage of supply from a break-down, the learned counsel referred to the evidence on the subject and as to the time occupied by the process of restitution he pointed out that Mr. Crompton put it at half a minute only and Mr. Swinburne a second or two. Therefore he thought they might resolve to ridicule all the silly talk about panics in theatres. He could understand a panic in a theatre arising from a tremendous blaze before people knew what they were about, even if the blaze suddenly ceased, because, of course, they might think a conflagration was about to set up, and they might make a rush; but he could not understand the common-sense even of the public of London being at such a low ebb that a momentary eclipse of light, a momentary darkness, lasting a second or two, would result in a catastrophe. According to Mr. Swinburne the thing would be over before they could scarcely recognise it; and before a lady had time to say "Oh dear," or a gentleman had time to say something else (laughter), the whole thing would be at an end. Another objection was that with regard to leakage from primary to secondary mains. That had been spoken of as though it was a recognised difficulty in working transformers, but that difficulty had been overcome long ago. The objection as to the dangers of transformers in private houses was answered by the appearance in the box of Mr. Heaphy, the adviser of the Phœnix Fire Office who was distinctly of opinion that there was no danger at all; and there was the further evidence of Mr. Ferranti, who said he used transformers in private houses for the last five years and never had an accident. The learned counsel proceeded to deal with other objections as to the want of uniformity of pressure with the transformer system and as to there being no known motor adaptable to the transformer system. On the question of the relative expensiveness of the transformer and the direct systems, he said he could not help thinking, in spite of what Mr. Moulton said, that the result of the comparison was just the other way about. They knew the end of their expenditure, but the advocates of the direct method supplemented by storage did not know the end of theirs. Dr. Hopkinson gave the cost of the accumulators at £30 per horse-power, with a loss of 30 per cent. in working. Mr. PEMBER then proceeded to deal with the position of the Chelsea Company and the Electrical Power Storage Company, maintaining that it did not warrant them in being entrusted with the Provisional Orders they sought. As to the position of other companies, such as the Westminster and St. James's Company, he said they were seeking to pick the plums out of the pudding, and that London ought to be lighted as a whole rather than small areas being allotted to small companies. Dealing with the dissents of the local authorities, he contended that they were not meant to be final, but that there were special circumstances connected with London which justified the Board of Trade overriding them if it thought fit. In somewhat strong terms the learned counsel dealt with the agreement between the Strand and Marylebone Board of Works and the Metropolitan Company, which, he contended, was contrary to public policy and contrary to the spirit of the Acts of 1886 and 1888, and virtually meant that the Metropolitan were willing to agree to anything in order to secure a monopoly. He did not think there was anything in the attitude of the local authorities which would prevent the Orders being given *sub modo*, leaving to the Board of Trade the subsequent decision of matters of detail.

Major MARINDIN said it would now be his duty to prepare his report to the Board of Trade, which he would do without loss of time, but he was sorry he could not give the parties any exact indication when it would be ready.

Mr. PEMBER expressed the thanks of himself and his colleagues to Major Marindin for the patient and able manner in which he had conducted the Inquiry; and Major MARINDIN having acknowledged the compliment, the Inquiry terminated.

CORRESPONDENCE.

THE GANZ ALTERNATING SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the reproduction in your esteemed journal of Prof. Forbes' Paper about electric lighting central stations, read before the Institution of Electrical Engineers, will you kindly allow us space to correct some erroneous remarks and statements upon our system of distribution?

Speaking of transformers, Prof. Forbes says:—"I have elsewhere described the Westinghouse converter, which I have tested and found to be very efficient, even though the largest one he is in the habit of supplying is only for forty lights. Only the larger size of Zipernowsky converters is so efficient. Three sizes are made, varying in efficiency from 95 down to 88 per cent., though the latter is a converter suitable for 25 lamps."

We cannot but remark that the manner in which Prof. Forbes speaks about the efficiency of the Westinghouse and the Zipernowsky transformer is apt to throw discredit upon the latter, which could not have been Prof. Forbes' intention, as otherwise he would not have failed to give exact numerical data about the Westinghouse converter also. Besides, the numbers given with regard to the Zipernowsky transformers are not right, as they differ from our measurements as well as from those of other electricians who have tested our transformers. The exact values of the efficiency are from 95·5 down to 92·5, the latter number relating to the smallest type of converter we manufacture for lighting purposes.

Though satisfied by the fact that Prof. Forbes recognises the lately patented Elwell-Parker dynamo as our oldest type with wooden cores in the armature coil, we cannot share Prof. Forbes' views in regard to the advantages of an internally rotating armature.

We cannot understand why the rotating magnet wheel may not just as easily be balanced as a rotating armature, especially as Prof. Forbes himself admits that the magnet wheels of our dynamos are very well equilibrated.

That, moreover, the armature winding of the Westinghouse dynamo might better withstand centrifugal forces than the

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winding of the magnets of our dynamo, we must decidedly dispute. The single induction coils of the former dynamo are simply laid upon the bare drum, covered with mica, and then fastened by means of wires wound around them. The winding of our magnets is placed upon zinc shells, which are slid upon the magnet cores and held down by means of strong coil holders of bronze, which are again fixed by a bolt passing through the magnet poles.

Certainly this method of fixing the coils is a solid and constructive one. Besides, it is quite doubtless that a winding which has to produce high tension currents can be far better insulated when fixed that when revolving. A further advantage of our dynamo is that every single armature coil may be taken out and replaced by another one, whilst in the Westinghouse dynamo this is impossible. This advantage allows an easy and quick repair, and only requires a reserve of one or two coils for our dynamo instead of a whole drum for the Westinghouse dynamo.

It is, therefore, not at all in respect to firmness that we run our dynamo not at so high a speed as Westinghouse; only the relatively low number of alternations (5,000 per minute), which we have chosen on principle, has caused us to take a low number of revolutions, and not *vice versâ*, as Prof. Forbes assumes.

That we by this means are enabled to couple our dynamos in parallel is not a secondary result, but just the end we were aiming at; and we believe that at present no practical electrician will hesitate to acknowledge the coupling of the dynamos in parallel circuit to be a vital question of any parallel system of central station distribution.

The reasons which Prof. Forbes gives against the parallel coupling of dynamos do not exist, and even if they existed they could not be valid enough to render the parallel coupling of the alternating-current dynamos disadvantageous or even less desirable. A single district can as easily be cut out from a system of parallel-coupled dynamos as with independently running machines, seeing that the leads for each district can be branched off in the central station.

Prof. Forbes has seen an example of this in Rome, where six feeders are supplied from paralled-coupled dynamos. As to the increase of the resistance of the line with the use of alternating currents, it is only very small in our plants, because of the low number of alternations and the small cross-section. What is to be kept in mind is that the coupling in parallel of the dynamos is not identical with the use of one single main. If other manufacturers do not couple their dynamos parallel, it is likely that the reason is not that they have found this method of supply unsuitable, but lies elsewhere.

The introduction of great self-induction is not necessarily accompanied by a diminution of the plant efficiency, as the self-induction may be obtained, not only by the enlargement of the dimensions, but also by a change of the constructive forms.

To keep the tension of such a dynamo upon a constant value, the existing current must, indeed, be varied within further limits than in dynamos with smaller self-induction; but we think that the regulation in both these cases causes about the same difficulties; Prof. Forbes himself has acknowledged our method of regulation to be the best among all known to him.

As to the cost of transformers, they indeed rise with the use of a low number of alternations, but although the total cost of the transformers in a plant forms a considerable sum, the rise of this total sum is quite insignificant against the other advantages of a low number of alternations. In fact, the disadvantages in using a low number of alternations are disappearing against the advantages obtained thereby.

We are much astonished to see Prof. Forbes use the expression, "Gaulard and Gibbs system, with converter put in parallel," several times. We will only call attention to a Paper read by Prof. Forbes on February 19, 1886—that is almost a year after our first demonstrations in the Exhibition of Budapest—in which he declares the Gaulard and Gibbs' series system to be the only good one, and the parallel system to be quite impracticable. It was not until after we had already carried out several plants that Gaulard and Gibbs understood that the series-coupling renders the maintaining of a constant secondary tension impossible.

If the series system in 1885 was called the Gaulard and Gibbs' system, after those who first employed it on a larger scale, it is very unjust of an authority like Prof. Forbes, a few years later, after a better system had been found and employed by others (in this case indisputably by our engineers, Messrs. Zipernowsky, Déri and Bláthy) simply to ignore this fact, and even to christen the better system by the name of those who in the meantime have preferred to lay no further claim to the paternity of their own system. We are the more astonished at this proceeding of Prof. Forbes, as he brings in the above-mentioned wrong assertion in connection with the central station at Rome, and as he mentions immediately afterwards that he had received full information from the undersigned, while from our information, as well as from those of Mr. Pouchain and Prof. Mengarini, he quite certainly ought to have known that in Rome not the Gaulard and Gibbs, but the Zipernowsky-Déri-Bláthy system of distribution has been brought in use.—Yours, &c.,

GANZ AND CO.,
per C. Zipernowsky.

Budapest, April 30, 1889.

THE UNITED TELEPHONE COMPANY *v.* THE NEW TELEPHONE COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You are no doubt aware of the action that the United Telephone Company is taking with regard to all instruments that have been manufactured and sold by the New Telephone Company. I lately purchased some of these instruments, and am now required either to surrender them to the United Telephone Company or to pay a heavy yearly rental. If I give up these instruments I can get no compensation, for the New Telephone Company is now in liquidation. Had it not been so that company would no doubt have defended its customers from all claims. With the United Telephone Company might is evidently right, and finding a rival in want of funds, they take the opportunity of striking a blow which they know cannot be returned. There must be hundreds of purchasers of these instruments who are in the same position as myself, and who must be greatly inconvenienced by the high-handed action of the United Telephone Company. Might I suggest, through the medium of your paper, that though it may not be worth the while of any one single-handed to fight the matter, yet if a considerable number were to combine and refuse to give up the instruments they have bought and paid for, and also agree to share the legal expenses incurred, then such legal expenses would not fall heavily on any one. I consider we should have a very good case, and I would gladly subscribe my share and help to destroy a monopoly which greatly retards the use of the telephone amongst an enormous number of prople who would otherwise use it.—Yours, &c.,

J. A. McMULLEN.

25, Liverpool-street, London, E.C., April 7, 1888.

DR. LODGE'S EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The travelling brush noticed by your correspondent calling himself "Ignoramus" must, *I imagine*, have been merely an optical effect. I did not see it myself. May I ask if it was noticed by others?

I may take this opportunity of remarking that in the artistic improvements of my diagrams on your page 732, *case a* of Fig. 2 is omitted, and the sketch called "case *a*" is really a variety of *case b* (2).

My *case a* represented a simple flash from a single cloud to earth: the cloud not raining.

I fear the bottoms of the clouds are not flat enough to satisfy a meteorologist.

One or two other little errors:—In Fig. 1, case *b* (1), a dotted line from M to outside of jar is omitted. The last sentence of printing under the diagrams should run:—"In case *b* (1) the rain-shower or leak is permissible but unnecessary."—Yours, &c.,

OLIVER J. LODGE.

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THE HÉROULT ALUMINIUM PROCESS IN GERMANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In No. 569, Vol. XXII., 12th April, of your esteemed journal we read on p. 644 a notice headed "Cowle Patents in Germany," the final of which runs thus:—"The Héroult process, which is employed at Oerlikon, is not, so we are informed, patented in Germany," which prompts us to submit the following corrections:

1. The Héroult process is not being practised at Oerlikon, but in our establishment at Neuhausen (Falls of the Rhine).

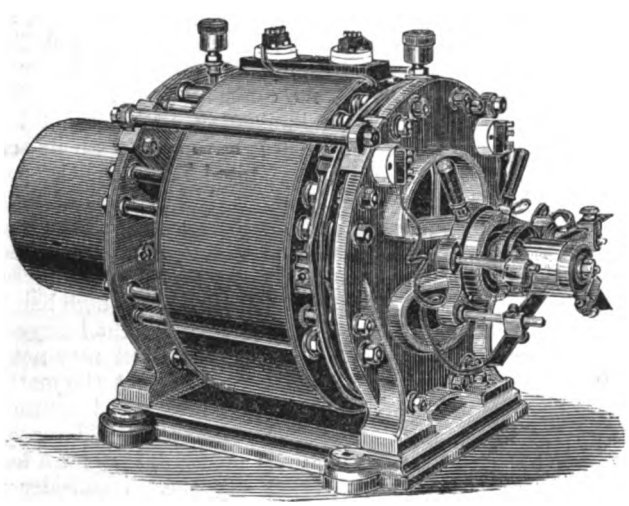
2. The Héroult apparatus for continual production of alloys of aluminium and similar metals by electrolysis is patented in Germany.

We request the favour of causing a correction of the said notice in the above sense to be inserted in your esteemed journal, and remain, Sir, yours, &c.,

J. CHINDLEY and W. WILLIAMS.
Aluminium-Industrie-Actien-Gesellschaft
Neuhausen, April 30, 1889. Der Vorstand.

THE GANZ ALTERNATING MOTOR.

The accompanying illustration is taken from a photograph of the new Ganz alternating motor, of which we gave some account



Ganz Alternate-Current Motor.

Owing to the indistinctness of the photograph from which the engraving is taken it is possible that the actual commutator may not be exactly as represented above.

in our issue of April 19. Messrs. Ganz and Co. inform us that they are already carrying out several installations for the transmission of power with the new motor. At a distance of 1½ miles from the Wiener-Neustadt Brewery water-power to the extent of 80 horse-power is available, and at this point a Ganz alternator, running at 500 revolutions, and giving 25 amperes at 200 volts, is now being erected for the supply both of light and motive-power to the premises. The lights are of course run off transformers. Power is furnished to the machinery by means of two alternating motors of 10 horse-power each and one of 5 horse-power. The two larger machines run at 830, and the smaller at 1,250 revolutions per minute.

Messrs. Ganz also send us the following table, in which some particulars as to the performance of the motor are given:—

Revolutions per minute.	Output alternate current motor.		Apparent energy consumed, Volt-Amperes.	Actual energy consumed.		Proportion between actual Watts consumed and apparent Volt-Amperes.	(Commercial) efficiency per cent.
	Horse-power.	Watts.		Watts.	Horse-power.		
600	15	11,000	18,000	15,800	21·5	0·88	77·0
700	19·8	14,600	24,200	18,600	25·2	0·77	78·5
730	30·7	22,400	29,800	27,700	37·6	0·92	80·9

COMPANIES' MEETINGS & REPORTS.

Brazilian Submarine Telegraph Company (Limited).

The thirty-first ordinary general meeting of the shareholders in this Company was held on Wednesday, at Winchester House, Old Broad-street, under the presidency of Sir James Anderson (the Vice-Chairman of the Company).

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting and the minutes of the last ordinary and extraordinary general meetings. These minutes were confirmed as correct by the present meeting and signed by the Chairman. The report of the Directors was taken as read.

The CHAIRMAN expressed great regret at the absence, through illness, of Viscount Monck, and said he was quite sure the shareholders would join with the Directors in the sincere wish that his lordship's illness would be only of a temporary character. Fortunately there was little to say, for the report of the Directors was a very full and satisfactory one. It dealt with the accounts to December 31st last, and it would be seen that as compared with the corresponding period of the previous year there had been an increase of over £30,000 in the revenue, while the expenses had been more by £2,000 than in the preceding half-year. The increase in the expenses, however, had been mainly owing to the fact that they had written a certain amount off the value of the cable in stock—a plan followed by other similar companies, as cable was not now so expensive as formerly. In the working expenses in this country and at the stations there had been a saving of £400. In paragraph 4 of the report they referred to having reduced the tariff on the 1st ult.—too short a time, under any circumstances, to form any reliable idea as to the result of the alteration; but unfortunately there had been interruptions on the Western and Brazilian Company's system and the Government land lines, so that they had had a very bad month. They had a right to expect that they might hear any day or hour of the restoration of the whole of the system, when he hoped that their traffic would come back. It was right for him to have mentioned this accident, which occurred last month, though the report only went up to December 31. In paragraph 5 reference was made to the African Direct Company, in which they had £75,000 invested. The Eastern and South African Company had extended that line down to the Cape of Good Hope, and they had made a joint-purse arrangement with that Company and the African Direct Company, and all the connecting companies. That line would be open for traffic within the next forty-eight hours, and he thought that the £75,000 referred to, which was now lying unproductive, would then produce something. He concluded by moving the adoption of the report and accounts.

Mr. FREDERICK YOULE seconded the motion.

Mr. NEWMAN inquired why the Directors had reduced the tariffs if they anticipated a loss. This line was mainly a business line, and people who had to deal with thousands and tens of thousands of pounds were not likely to be stopped from telegraphing for the sake of a few shillings.

Mr. W. GRIFFITH thought the shareholders might congratulate themselves on the state of the Company's business up to December last. They must also join in the regret which had been expressed at the absence of Viscount Monck, but they might congratulate themselves on the able way in which his lordship's place at that meeting had been filled. The Directors proposed in June to distribute £13,000 out of the amount now carried to next account, or 1 per cent. on their share capital of £1,300,000; and if they could distribute the unclaimed dividends and interest, amounting to between £6,000 and £7,000, they could divide something like 10s. per cent. more. He might state that within the last six months certain changes had been made in the law by which the accounts of companies could be simplified, and by which trustees, directors, and others might get rid of such items as he had mentioned after a certain period without any danger to the Company and with great benefit to the shareholders.

The CHAIRMAN observed that the unclaimed dividends had now been greatly reduced.

The MANAGING DIRECTOR: The amount stands to-day at £1,000 or thereabouts.

The CHAIRMAN, continuing, said they must not be in a hurry to deal with this item. With regard to the remarks of Mr. Newman, he thought that all who were closely watching the interests of telegraph companies had come to the conclusion that low tariffs would be forced on them if they had not the good sense when they could afford it to reduce the rates gradually. It was quite true that a man who spent 6s. a word would spend 7s., but it was also true that if the tariffs were reduced an impulse would be given to the traffic, which might otherwise be stagnant. He thought, too, they must admit that 7s. was a high tariff for a single word; and now that they had had it for many years, and had paid good dividends, and had duplicated their cable, it was only wise to reduce the rate, and to look to the

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development of the traffic to recoup them for the sacrifice which they would make at first.

Mr. NEWMAN said it was not only in their Company but in others that the mistake was made of considering the public first and the shareholders afterwards.

The CHAIRMAN replied that the shareholders must allow the Directors to judge of the expediency of what they did. They knew the demands which were made upon them in every direction, and the threats that were made about competition, and those threats would be carried out, and very properly carried out, if the rates were not reduced.

The resolution was then carried unanimously.

Mr. JOHN ANDERSON proposed a vote of thanks to the Chairman and Directors, which was seconded by Mr. GEORGE ANDREWS.

Mr. GRIFFITH, in supporting the motion, said that their business was increasing, and if the Directors thought it wise to lower the rates the shareholders must admit that they had greater experience as to the way the business of the Company should be managed. He agreed that it was unpleasant to see the rates lowered, and they all desired an increased dividend ; but, on the other hand, if the business increased they would not lose by the lowering of the rates, and they would certainly save themselves from the serious danger of opposition from which the Anglo-American Company, for instance, had suffered so greatly. He thought the shareholders might leave the question of the rates in the hands of the Directors.

The resolution was carried unanimously.

The CHAIRMAN, in acknowledging the vote, observed that the question of reducing the tariffs had been before the Directors for years, and he was sure that in the course they had taken they had gone in the right direction.

The proceedings then terminated.

West India and Panama Telegraph Company.

The twenty-fourth ordinary general meeting of the members of the West India and Panama Telegraph Company (Limited) was held at Winchester House, 50, Old Broad-street, on Wednesday, the 8th May, 1889, under the presidency of Mr. C. W. Earle.

The SECRETARY (Mr. R. T. Brown) read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting as correct. The report of the Directors was taken as read.

The CHAIRMAN : When I had the pleasure of meeting the shareholders this time last year, I called their attention to the fact that the half-year's accounts which they were at that time considering were the best they had had presented to them since the autumn of 1883. On this occasion we have an improvement upon the corresponding period of 1887 of about £1,600, although in the half-year of 1887 we had some advantages which we have not had in the past half-year, in the hire of the ship and the employment of it, thereby relieving our accounts of so much during the time that one of the ships was coming home to take out new cable to the West Indies. This improvement of £1,600 is partly accounted for by the increase of the traffic of about £1,050 ; but we must look for something to set off against the extraordinary advantages of the preceding period, and these must be found under Abstract C, which deals with the repairs of the cables. We have there an expenditure of £8,402, against an expenditure of some £12,000 odd in the corresponding period of the previous year, and this is the main cause of the improvement in the half-year under review. I may tell you that, taking the average for the last nine half-years, the expenditure under Abstract C, which refers to the repairs and renewal of cables, has been about £5,000 more than it was this half-year, and, therefore, in that respect the half-year has been an exceptional one. I wish particularly to call the attention of the meeting to the fact, because sometimes we find that when there is a good half-year like this it is made use of to advocate various schemes of dividing the reserve ; and, in fact, at such times people are led to suppose that all our difficulties and dangers are passed, and that we are going to enter into a time of great prosperity ; but every one who has anything to do with telegraph cables knows that the accidents to which they are liable are very uncertain in their coming, and although we have done very well this half-year with our cables, that good luck may not follow us in the future. I am rather of opinion that owing to the experience we have gained of the nature of the seas in which our cables lie, we are able to do something to diminish the interruptions, but that may be mere supposition. It is very difficult to prove—it requires a very long time and long-continued experience to prove—the success of such an occult business as the keeping of cables in repair. With respect to our traffics for the last five half-years, we have had a small increase, and in most businesses that would lead some one to suppose that there was some development going on in the traffic of the West Indies ; but when you look back at the traffic returns of a longer period than five half-years you see what falls and bounds to which our traffic returns are exposed. In the last half of 1885 and the first half of 1886 we had a falling off amounting to £7,000 over the preceding period. Now we have nearly recovered that by the gradual increase in five half-years, and we are about at the same level as we were then. Therefore, I am not disposed to be too sanguine about any great development and increase of traffic to the West Indies. It is a traffic that is liable, like our repairs, to great fluctuations, depending, as it does, principally upon the conditions of trade and the condition of the sugar industry, which are so exposed to influences of various kinds. There is an allusion in the report to the French Company that has been started in our very midst. At present that Company does not interfere with us very much. It goes to Venezuela, a point we do not touch at ; and though it has taken some little traffic away that used to come from Venezuela by post to our line, yet I do not think there is very much harm done at present. The danger, of course, of such an organisation is the temptation to go to other places which are served by us ; and when you consider the very small amount of traffic that there is at almost every one of the stations (at none is there a traffic of any considerable amount), it is rather curious that people should wish to lay other cables for carrying what traffic there is. But our friends the French are a curious people, and if they get an idea that the glory of their country is concerned, or that perhaps a little blow can be given to England or English interests they come down with their 5-franc pieces with great alacrity. Therefore it is a source of some anxiety that this French cable goes through the Caribbean Sea. With respect to our prospects, it is not safe at any time to prophesy, but I think this half-year that we are now in—the first half of 1889—will see us through the arrears on our First Preference Shares to a certainty. We shall then commence to pay off the arrears on the Second Preference Shares, and if all goes well—if the traffics remain as now, and no great misfortune occurs to us—I think in the course of two years we shall be quite free from all these liabilities, and we shall begin to pay something to our ordinary shareholders, who deserve every consideration after the long and patient way in which they have borne the privation of all dividend. With these remarks I beg to move :

"That the Directors' report and accounts to the 31st December, 1888, submitted to this meeting, be read, and the same are hereby received and adopted, and that, as recommended by the Board, a payment of 12s. per share on account of arrears of dividend on the First Preference shares be and the same is hereby declared."

Mr. WILLIAM FORD : I beg to second the resolution, and I have the very greatest pleasure in doing so, because I really believe that the accounts indicate a greatly improved prospect for the ordinary shareholders.

Mr. FITZGERALD said he desired to ask one or two questions respecting matters of policy, for other questions were replied to with the greatest readiness at the office. He observed that in the past half-year £1,000 had been put to the reserve fund. In the previous half-year the amount was £2,000, and in the half-year before that £3,000 was put to that fund, so there had been a gradual reduction. At the present time the reserve fund amounted to £134,000 odd, plus what the securities would fetch in the market by their increased value over cost price. Roughly, he believed their securities were worth within £2,000 of £150,000. Besides the £1,000 which he had mentioned as having been added to the reserve fund in the past half-year, the interest on the fund had also been added to it. The interest on the reserve fund amounted to £5,000 a-year, so that in the past half-year the reserve fund had been increased by £3,500. The question he desired to ask was whether, having regard to the long time during which the shareholders had not received any dividend, they might take it that unless any unforeseen circumstance arose in the future that amount of £3,500 would be something like the amount that would be put to the reserve fund in future half-years, so that the day in that case would not be far distant when the interest of the reserve fund would be considered by the Board as sufficient by which to increase that fund. In that case he thought the Chairman's figures were not quite sanguine enough, because he himself thought that within 18 months or two years the whole of the present liabilities would be cleared off, even supposing that the present traffic did not increase, and that they could not effect any other economies. In that way about £17,000 would be available for the Ordinary dividend, which would give something like 2 per cent. on those shares, and at their present miserable and, as he considered, wrong price on the market, the return would be about 10 per cent. He wished it to be clearly understood that he made these observations without any hostile feeling to the Directors. He also desired to know whether it was not possible to do the repairing work with one vessel instead of two. He found that in the previous half-year one of the vessels was employed under charter party. He thought it reflected great credit on the Directors in having obtained employment in that manner for one of the vessels. But naturally the question arose whether it was possible to do with one vessel, which would mean a very considerable saving each half-year.

Sir G. H. CHAMBERS wished to echo the remarks made by the previous speaker as to the inadvisability of anything in the way of hostile criticism. No one knew better than he himself that when the responsibilities of directors were placed upon gentlemen they ought to receive all the support that could be given to them by their shareholders. At the same time, when there were differences of opinion he thought it was just as well that the shareholders should state their views, which should have the consideration of the directors. The amount payable to the Preference shareholders annually was £23,540. The accounts now before them and the accounts of the previous half-year showed that out of the profits of the year 1888 they had paid no less than £41,475, that being a difference of £17,935 taken out of the profits of 1888 towards paying the arrears on the Preference shares. The accounts also showed the amount now due as at the 31st December, after the present payment had been made, and that amount would be about £35,000 ; therefore in the course of a couple of years, as stated by the Chairman, they might expect that that amount would be disposed of. They would then have for the ordinary shareholders nearly £18,000 available for dividend in the year 1891. The accounts showed, moreover, that in the course of the year 1888 they had added £7,820 to the reserve fund, partly from the dividends received on the investments of the fund. Adding that sum to the amount of nearly £18,000, which they would not have to pay in 1891 to the preference shareholders, it would be seen that if the two amounts were put together there would be a fund available for dividend on the ordinary shares enough to pay 3 per cent. He did not want to anticipate too much, but it was quite clear that the Chairman was looking forward to the payment of an ordinary dividend at the date he (the speaker) had mentioned. But the question was whether they might not receive something in the meantime. It was clear that of the ordinary revenue of the company the ordinary shareholders had no right to any portion until the preference

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shareholders had received their rights. Their position was about £14,000 better than appeared from the accounts before them—that was in the increased value of their investments; and so far as one could judge, knowing how much the value of money had been diminished, they might at least expect that the present value of their investments would be maintained. It must be remembered that that fund had been contributed out of money which would have otherwise been divisible among the ordinary shareholders. The fund was for the protection of the debenture holders in the first instance, then of the preference shareholders, and the ordinary shareholders followed. He thought under these circumstances the increased value of the securities might be regarded as a fund which really belonged not to the Preference shareholders but to the ordinary shareholders of the Company. They had paid out of revenue over £23,000 a year for repairs and renewals, and that had been extending over a considerable period. At the present time a large part of their system was new cable, and it was estimated that the life of a cable was thirty years. Assuming that that was so, and that they continued to pay out of revenue for thirty years so much as had been charged in the accounts there would be a sum of £700,000 for repairs and renewals without touching the reserve fund. It appeared to him that the amount of the reserve fund was now sufficient for all ordinary purposes unless anything extremely adverse occurred. Then there was the amount of the profit on the investments, and the interest on the investments; it would be a question whether that might not be appropriated to some dividend for the ordinary shareholders, without waiting for the year 1891 to come. He thought the ordinary shareholders were quite entitled to the improved value of the property; and it would be the duty of the Directors to take that point into their consideration, and to decide whether some dividend might not be paid to the ordinary shareholders, as he (the speaker) had suggested. It would be an advantage to the Company to be declaring a dividend.

Mr. GUESDON said that all the shareholders appeared to be of one mind as to the confidence they reposed in the ability of the Board. He was not himself quite so much of a pessimist as the Chairman with respect to the future of the West Indies. He thought that circumstances were occurring, particularly the better position in which sugar would be placed, which he hoped would increase their traffic receipts. With regard to the question which had been raised as to the French Company and the possibility of competition, he held it to be a matter of the highest importance that they should have a strong reserve fund, because when one was able to show to an opposition company that one had the tools to fight with it made a very great impression, which would make their possible intended opponents thoughtful before entering into a fight. He thought it was of great importance that the reserve fund should be left, as hitherto, entirely at the discretion of the Directors. The experience which the Board had gained as to the management of the Company's affairs must render them capable of forming a sound opinion, and he was sure they would be quite as pleased to pay a dividend as the shareholders would be to receive it. Business, however, was one thing, and sentiment another, and he hoped that nothing would be allowed to interfere with what business experience and sound policy would dictate. He hoped, therefore, that the shareholders would still exercise patience and leave the Board to pay a dividend when they could do so.

Mr. RUSSELL referred to the £50,000 of Debentures bearing 5 per cent. instead of 6 per cent. as formally. He congratulated the Directors on the reserve fund, and as to the discretion they had shown in investing the money forming it, the existence of which greatly strengthened the position of the Company. Did he understand that the reserve fund was hypothecated with all the other assets of the Company to the debenture holders? If that were so the reserve fund would have to be reduced by something like £50,000. They had to pay £2,500 a year for interest on the Debentures, and he thought it would have been much wiser from a financial point of view if the Directors had sold out some of the stocks at a considerable premium, and so have obtained the money which they required when they issued the Debentures. They would thus, he said, have saved £900 a-year. He wished to know the opinion of the Directors as to the life history of a cable. He believed that in their case twenty-five years would be an under estimate. He thought they might do with one ship if they put down good cable. It was an immense expense to have two ships. The Company was now earning a dividend on the Ordinary shares. He congratulated the holders of the First and Second Preference shares, as they were called—when in reality they were guaranteed shares—for the dividend on them was not contingent on the profits of each separate year. He thought if they had been, all the shareholders in the Company would have been much better off.

Mr. SAUNDERS inquired whether the investments were shown at their cost price, or were set out at their market value?

The CHAIRMAN: Their cost price.

Mr. GUESDON inquired when the Debentures matured?

The CHAIRMAN: At the end of 1891. Considering the tone which has characterised them it is a great pleasure to me to answer the criticisms which have fallen from the different shareholders. Mr. Guesdon referred to my knowledge of the prospects of the West Indies sugar industry. I cannot accept that compliment, especially in the presence of my friend, Sir George Chambers, who is very much concerned in the West Indies, and in the sugar and other industries there. I think I had better first deal with the question concerning the ships. For a long time in this Company we had only one ship, and it was with considerable heart-tearings, if I may use that expression, that we at last decided that we must have two. In looking back at the last two half-years, it is possible to say that we should have done as well with only one ship; but you must remember that these accidents that happen to cables are cumulative. They occur in groups, and we are then at our wits' end to know how to repair them. It is not only the loss of traffic that we have to consider but the injury it does to us in connection with the Colonies.

A SHAREHOLDER inquired whether the cables were not duplicated.

The CHAIRMAN: Some of them. We have two cables that are not, the one to Demarara and the other to Barbadoes. The Colon cable is not duplicated, but that is not important. Sometimes we have two cables break at the same time. Some of these small cables go in pairs, and when such breaks occur the Colonies are without communication, and there is a considerable howl. We have had as many as 11 cables broken at one time.

Mr. FORD: The loss of revenue consequent on that interruption was greater than the cost of the ships.

A SHAREHOLDER: When was that?

Mr. FORD: In 1880.

Mr. FITZGERALD: We have better cables now.

The CHAIRMAN: I cannot say that. The original cable was quite good enough. It is picked up now in first-rate order where it lies on good ground, but no one would like better than the Directors to get rid of one of these ships. It is a very heavy incubus, but the second ship was not bought hastily. Though you may go on for a little time without the ships being much used, yet when the breaks occur you would be in a very bad way if we had not these vessels, and we should have a great loss, not only of the traffic, but the subsidies, and there would also be the loss of the good feeling in the Colony, which is rather difficult to obtain. I do not see my way yet to hold out any hope of getting rid of the second ship.

Mr. FITZGERALD: The matter will not be lost sight of?

The CHAIRMAN: No; but we have a great many complicated questions to consider with respect to that.

Sir JAMES ANDERSON: We have often discussed it.

The CHAIRMAN: With regard to the question of reserve fund, let me say that the additions to it are not made by rule of thumb. It is done on a certain calculated system. For many years our reserve fund was very much in arrear of what it ought to be to pay for the depreciation calculated up to that time for the life of our cables, and we had therefore to add very large sums to bring up the amount to the prescribed level. The fund is now about at the level. We have had nineteen years' life

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of the cables, and our calculation brings us up to requiring that sum that is now in our books as reserve fund. The depreciation that ought to be laid aside is laid aside up to the 19th year of the Company's cables. When we put in any new cable we take the value of it into consideration in setting aside a sum to reserve—that is, if we put a new bit of cable into an old cable that has been 10 years in existence we take into consideration the 10 years' accumulation. The whole thing is calculated on a system taking into consideration three things—the life of a cable, the interest we can get on prudent investments, and the cost of a cable. The reserve fund is a depreciation fund which ought in the time that we allow for the life of a cable to put us in a position to renew the whole cable. That is to say, we ought after 30 years, either in meal or malt, either in new cable put in or in sovereigns invested, to have money enough to cover the whole cost of the system. Whether we shall go as far as that I cannot say. It is a good big sum, but you must think of what the reserve fund may be called upon to supply. There are some Directors here who will tell you of the repair of a cable that cost £90,000. One cable in this Company cost us first and last to repair £50,000—the cable between Jamaica and Porto Rico. In cable alone that cost £32,000, besides the expenses of the ships. It does not therefore do to be too hopeful as to being able to take money out of the reserve fund and pay it away in dividend. The profit that has been made upon the investment has been very fair, amounting to about £13,000, but whether the directors would consider it prudent to deal with that in the shape of dividend I have not had an opportunity of discussing with them. You must remember that the market might fall, and in that case, instead of finding ourselves several thousand pounds to the good we should be several thousands to the bad.

A SHAREHOLDER: In case of war?

The CHAIRMAN: Yes, in case of war. The renewal of the debentures occurred two years ago. We renewed them at 5 per cent. instead of 6 per cent. Our having those £50,000 of debentures has proved more valuable than if we had sold any of our securities, owing to the increment in their value. Had we paid off that £50,000 we should not be as well off as we are. We cannot pay them off now until the period of five years has elapsed.

Mr. JOHN NEWTON: Instead of paying off the debentures you have kept your securities, which have since increased in value by £12,000, and for that you have paid £500 a-year. I think you have in that way made a good bargain.

The CHAIRMAN: We shall consider all that has been said. He then put the resolution, and it was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. FORD, Mr. Henry Holmes was re-elected a Director; as was also Mr. Henry Weaver, on the motion of the CHAIRMAN, seconded by Sir JAMES ANDERSON.

Mr. J. G. Griffiths was then re-appointed auditor.

Mr. GUESDON then proposed a vote of thanks to the Chairman and Directors.

Mr. FITZGERALD seconded the motion, which was carried unanimously.

The CHAIRMAN briefly acknowledged the vote, observing that it was one of the bright moments in a somewhat anxious business to receive such a cordial acknowledgment from the shareholders of their appreciation of the services of the Directors.

The proceedings then terminated.

NEW COMPANIES REGISTERED.

THE ELECTRIC TRAMCAR SYNDICATE (LIMITED).—Registered by Davidson and Morris, 40 and 42, Queen Victoria-street, E.C., with a capital of £20,000 in £10 shares. Object, to acquire the letters patent granted to A. J. Jarman for an invention for "improvements in the construction of electro-motors for the propulsion of tramcars, electric locomotives, vehicles, and other purposes." The number of directors shall not be less than three nor more than seven. The first are J. Muirhead, P. E. Lentilhac, and H. G. Hemmerde. H. J. Archer, if willing to act, shall be appointed after completion of purchase. Qualification, £500 stock. Remuneration to be determined in general meeting.

THE JENSEN ELECTRIC MANUFACTURING COMPANY (LIMITED).—Registered by Batten, Proffitt and Scott, 32, Great George-street, S.W., with a capital of £80,000 in £5 shares. Object, to carry out an agreement, dated April 26, made between Clifton Shield and C. F. Helder of the one part, and J. M. M'Donnell, as trustee on behalf of the company, of the other part.

KESWICK ELECTRIC LIGHT COMPANY (LIMITED).—This company was registered on the 1st inst., with a capital of £5,000, in £1 shares, to provide Keswick and its neighbourhood with the electric light. Registered without special Articles.

LOTHAMMER GAS MANUFACTURING COMPANY (LIMITED).—On the 29th ult. this company was registered with a capital of £60,000, in £1 shares, to acquire certain patent rights in relation to improved portable apparatus for the manufacture of gas, upon terms of an agreement between François Josué Lothammer and S. H. Blumfield, and to manufacture gas and electrical apparatus generally. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; remuneration, £100 per annum each, and in addition 5 per cent. on the net surplus profits, after payment of 10 per cent. per annum dividend, but the total remuneration is not to exceed £2,500 per annum. Registered office, 6, Lombard-court, E.C.

PONTYPRIDD ELECTRIC LIGHTING COMPANY (LIMITED).—This company was registered on the 30th ult., with a capital of £10,000 in £5 shares, to supply electricity for light and power to the parishes of Pontypridd and Ystradyfodwg, county of Glamorgan.

CITY NOTES, &c.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.—The debentures of the Anglo-American Brush Electric Light Corporation were over-applied for, and the letters of allotment and regret have been posted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended April 26, 1889, amounted to £3,200.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of April were £4,000, as compared with £3,705 in the corresponding month of last year. The receipts for the month of January, estimated at £3,100, realised £3,221.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of April, 1889, amounted to £1,867, as compared with £1,800 last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Com pany for the month of April, 1889, amounted to £51,452, and to £51,582 in the corresponding period of 1888.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of April were £42,709, as against £37,331 for the same period of 1888.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of April, 1889, amounted to £21,000. From the 1st January to 30th April, 1889, they were £84,000, against, in the corresponding months of 1888 and 1887, £85,200 and £81,520 respectively.

MEXICAN TELEGRAPH (CABLE) COMPANY.—We gave the approximate result of last year's working in our issue of Feb. 22, p. 467. Later advices report that a dividend of 2½ per cent. has been declared upon the capital of $1,500,000. The earnings for the first quarter of this year are returned as follow (three months to March 31):—

	1889.	1888.	Increase.
Earnings	$94,271	$84,946	$9,325
Expenses	16,000	14,695	1,305
Net	$78,271	$70,251	$8,020

It will be seen that the net profits have increased over 10 per cent.

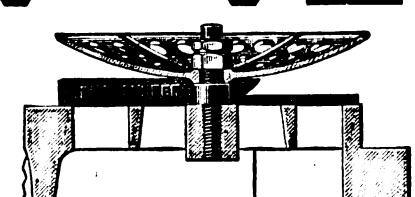
WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month ended 30th April, 1889, amounted to £8,125.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended April 26, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £2,009.

CHANGE OF ADDRESS.—The Monte Video Telephone Company (Limited) notify their removal to 25, Abchurch-lane, E.C.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, May 8, 1889.		Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 8, 1889.	
			TELEGRAPHS.			£ s. d.		Highest.	Lowest.
£									
1,770,360	Stock	12/6	Anglo-American	51½	52½	3 16 2	Jan., Apr., July, Oct.	53	52½
2,614,820	Stock	25/0	Do. Preferred	87	88	4 10 11	,, ,,	88¼	86½
2,614,820	Stock	...	Do. Deferred	18½	18⅞	...	February	19½	18⅝
130,000	£10	3/0	Brazilian Submarine	13⅞	14	5 0 0	Mar., June, Oct., Dec.	14	13½
112,900	£100	5%	Do. 5 per Cent. Bonds	102	104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106	109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½	14⅝	6 2 0	February and August	14½	14⅛
6,000	10	10/0	Do. Preference 10%	18½	19½	5 2 7	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3½	4	3 10 0	March & September	...	...
6,000	5	5/0	Do. Preference 10%	8½	9½	5 5 3	April and October	...	...
60,710	20	3/6	Direct United States xd	10⅝	10⅞	5 3 6	Jan., Apr., July, Oct.	10⅝	10⅜
380,000	10	2/6	Eastern	13½	13⅝	4 8 11	,, ,,	13⅝	13½
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝	15½	3 18 8	,, ,,	15⅛	14⅜
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock xd	106	108	3 14 1	May and November.	107½	105½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	4 10 11	February & August	109	108½
250,000	10	5/8	Eastern Extension	13½	13⅝	4 14 6	Jan., Apr., July, Oct.	13⅛	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102	104	5 15 5	February & August	103	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102	105	4 15 3	January and July	...	...
179,177	10	3/0	Globe Telegraph and Trust	7⅜	7⅝	4 15 1	Jan., Apr., July, Oct.	7⅝	7⅜
178,992	10	3/0	Do. 6 per Cent. Preference	14½	14⅝	4 1 4	,, ,,	14⅛	14⅞
150,000	10	5/0	Great Northern xd	15½	16	4 13 9	Jan., July, and April	16	15
17,000	25	2/6	Indo-European	39	41	6 1 11	April and October	40½	...
9,000	8	8/0	Reuter's xd	7	7½	5 6 8	April and October	7	6¾
15,609	10	3/0	West African Telegraph	7½	8½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	100	103	4 17 1	March & September	101	...
80,000	10	6/0	West Coast of America	10	10½	4 15 3	January and July	10½	9⅛
150,000	100	8%	Do. Debentures 8%	120	124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	1⅞	2	...	...	2	1⅞
34,563	10	12/0*	Do. 1st Preference 6%	11⅞	12½	...	April and October	12	11⅞
4,669	10	†	Do. 6 per Cent. 2nd Preference	12½	13½	...	...	...	...
45,181	15	6/0	Western Brazilian	12½	13	5 15 7	March & September	13	12½
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage xd	114	118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100	102	5 17 8	March & September	...	...
			TELEPHONES.						
224,850	14/0	4½d.	Consolidated Telephone and Maintenance	1⅛	1⅛	...	Yearly	⅞	1⅛
220,000	£1	3%	Oriental (11s. paid) xd	⅜	½	3 6 1	...	...	...
80,000	5	5/0	United	15⅝	16	4 13 9	June and December	16	15⅝
55,000	5	3/0	United River Plate	5⅞	6⅛	...	January and July	6⅛	6
			ELECTRIC LIGHT.						
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½	3⅝	...	...	3⅝	...
23,692	5	2/0	Do. (fully paid)	4½	4⅝	...	February & August	4⅝	...
79,934	5	...	Swan United (£3. 10s. paid)	2½	3	...	...	2⅛	...
			MISCELLANEOUS.						
87,350	12	36/0	Telegraph Construction and Maintenance	41	43	5 11 9	March and July	42½	41½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18	19	5 5 3	February & August	18½	17⅞

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S

DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

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The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 574.—Vol. XXIII. FRIDAY, MAY 17, 1889. Price Sixpence.

NOTES.

We have much pleasure in being able this week to fulfil the promise held out in our recent obituary notice of the late lamented Secretary of the Postal Telegraph Department. A finely-executed steel plate portrait of Mr. Patey is published with this week's issue of *The Electrician*, and we feel sure that the picture will be recognised as a most excellent likeness, and a work of art not unworthy of its subject.

We have received the following communication from the Secretary of the Institution of Electrical Engineers:—

"Dear Sir,—I am instructed to inform you that the Council have made arrangements for your being furnished with an abstract of the discussions at our general meetings. . . . Although the arrangement has only been made for the present year, the Council hope to be able to continue it in the future.

"Yours faithfully,

"(Signed) F. H. Webb, Secretary.

At the meeting of the Institute on Thursday next Mr. Mordey will read a Paper "On Alternate Current Working," on which occasion the President (Sir William Thomson) will occupy the chair. We believe that Mr. Mordey's Paper will prove to be of the highest interest; experimental results of a novel character may be looked for, and an attempt will be made to arrive at definite conclusions on several outstanding questions. This should, according to the programme, be the concluding meeting for the present Session; but in order to allow the Paper to be discussed it is understood that an extra meeting will be arranged.

The first evening of the discussion on Dr. Lodge's Paper at the Institution of Electrical Engineers was chiefly remarkable for the quantity of good-humoured *badinage* which was evoked, though candour compels us to own that the witticisms were not invariably of the most startling brilliancy. This result is not altogether what had been expected of the occasion, and, in fact, we could well have spared a good deal of incidental verbiage if we might thereby have gained a more serious consideration for the scientific aspect of the questions supposed to be under discussion. Mr. Preece, who spoke at great length, certainly did score a point when he observed that it remained with Dr. Lodge to show that the phenomenon of discharge from a metallic plate was strictly comparable to that of a thunder-cloud. His speech—which, as we have already observed, was rather long—was, however, chiefly devoted to the endeavour to show that the effects recorded in particular cases of lightning flashes could only have been caused by a uni-directional current. But in answer to this it is sufficient to observe that even an oscillatory discharge results in the final transfer of a definite quantity of electricity in a definite direction; and this, together with the observation of Prof. Ewing (*Electrician*, October 5th, 1888, p. 712) as to the effect of the diminishing amplitude of the oscillations, seems sufficient to account for all the known facts. On the other hand, Mr. Preece (whose remarks, we may add, were by no means brief) made not the slightest attempt to explain the various phenomena of surging, side-spitting, and other well-established inductive effects, which form so important a feature of Dr. Lodge's argument. Nevertheless, so confident is he in his opinion that lightning is a non-oscillatory discharge that, for the advancement of science and the honour of the Lightning Rod Conference, Mr. Preece is fully prepared to sit upon a barrel of gunpowder if protected by a conductor whenever a thunder-storm next arises. Prof. Adams, as Chairman of the Conference felt equally bound to maintain the infallibility of the opinions arrived at in 1881, and to do his best to slur over the value of the evidence since brought into court. Prof. Fitzgerald's speech made one regret that we cannot oftener have the pleasure of hearing him in London. He was unable to see that anything that had been said tended to upset the theoretical conclusion as to the usually oscillatory character of the discharge; but he agreed with Mr. Preece that it was desirable to repeat the experiments with a charged body more nearly resembling a storm-cloud. By the bye, we must not forget to mention that on this occasion Mr. Preece spoke rather longer than anyone else.

The statement that Electricity had annexed the whole domain of Optical science is fast being proved to be no empty boast. Already Dr. Hertz has made us familiar with the phenomena of reflection and interference of ether waves due to electro-magnetic radiation (*i.e.*, "light" waves whose length is enormous in comparison with those of the visible spectrum), and by means of a prism of pitch, with sides a metre square (see *The Electrician*, Nov. 9, 1888, p. 16), he has obtained an experimental proof of their obedience to the laws of refraction. Now, however, Dr. Lodge has gone a step further, and at the Physical Society, on Saturday last, he detailed a series of experiments carried out

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with a pair of plano-convex hemi-cylindrical hyperbolic lenses, also made of pitch. Each of these lenses weighs 2 cwt. and stands 85cms. high. The cylindrical shape was of course selected in order that the "oscillator" and the "resonator" might be placed wholly in the focus of the lens. With this apparatus he has performed such experiments as would be made with a beam of light and similar lenses of glass. Prof. FITZGERALD is anxious to go further still, and he is now endeavouring to obtain evidence of phenomena cognate to diffraction and to Newton's rings. As to the actual or possible existence of such phenomena —whether they be discoverable or not—it is scarcely possible to doubt.

IT is somewhat unfortunate that these experiments, which would otherwise be within the reach of everyone who possessed an influence machine, and who has mastered the general principles of electric radiation, can only be performed with lenses and mirrors, whether of glass or of pitch, of somewhat large and unwieldy dimensions. One reason for this is referred to in Dr. LODGE's Paper; but in the case of mirrors Prof. FITZGERALD mentioned after the meeting that this difficulty was first pointed out to him in a private letter from Dr. HERTZ, who stated that he had found that the oscillator tended to set up electrical vibrations in the metal of the mirror itself. This causes a concentration of electricity at opposite points near the edge if the mirror extends only to the limits of sensitiveness, but the effect is greatly diminished by increasing the size of the mirror.

ELECTRICAL engineers as a body have long since arrived at the conclusion that the dynamo has nothing to fear from the competition of the zinc battery. In face of the long experience of the past, it demands some hardihood even to hint at the possibility of the ultimate salvation of the primary battery as a source of electrical energy on the larger scale. Waste products—once the hope of every sanguine soul—are long since proved to be a delusion and a snare. Suppose, however, it were possible to work your primary battery upon an entirely regenerative principle; that is to say, to recover the zinc as metal, and the solution in its original form, then it follows that, except for inevitable wear and tear, cost of material would be a first charge only. This would be a most important step gained. We should have next to consider what is the cost of effecting the re-conversion. If this be accomplished—that is, *wholly* accomplished—by electric energy, we fall back upon the principle of the secondary battery, and we have merely to inquire what is the efficiency of the battery when used as an accumulator. There is, however, this difference: in the case of the zinc battery the metal passes into solution, and is not transferred to the negative plate. Consequently the re-conversion cannot be effected within the cell. This imposes the necessity of taking the battery to pieces; but, on the other hand, it has the advantage of allowing a large quantity of material brought from different batteries to be treated at one operation. We can now present the enquiry whether a zinc cell, such as we have hinted at, could compete with the dynamo in the wholesale distribution of electricity in the following form:—(1) What is the efficiency of the cell (regarded as an accumulator) compared with the efficiency of the distributing and transforming plant of the central station? (2) What would be the first cost of the batteries for a given district as compared with the first cost of distributing and transforming plant? (3) What is the cost of working and maintenance (including interest and depreciation) in each case, taking into consideration the cost of manipulation of the cells? We hope shortly to show that some advance has actually been made in the direction indicated, though we may leave our readers to reply to the above questions to their own satisfaction. We think, however, after what has been said, it will at least be admitted that the problem is worthy of candid and respectful consideration.

AT the meeting of the Committee of the Electrical Trades Section of the London Chamber of Commerce, on Monday last, the most important business in hand was the reception of the report of the Committee on Railway Rates. The text of this very able report will be found in this issue, and we have also dealt with the matter at some length in another column. We need, therefore, only remark here that the subject is one of great importance to the electrical trades, and that the report and schedules should receive the careful attention of everyone interested. A report was also received from the Correspondent (Mr. A. P. TROTTER) on the work already done by the Sectional Committees. From this report it appears that committees have been appointed to report to the General Committee on the following questions:—Overhead Wires, Railway Rates, the Establishment of a Standardising Laboratory, Standard Types of Apparatus, Standard Specifications. The three first-named Committees have already done good work. The Committee on Overhead Wires has induced the Board of Trade to promise that a copy of the proposed regulations shall be forwarded for its observations before their final issue. (We may add that at the present moment these regulations are in the hands of the Solicitor to the Post Office.) We have already referred to the work of the Railway Rates Committee. The Committee appointed to consider the question of providing a standardising laboratory forms part of a joint-committee in connection with one appointed by the Council of the Institution of Electrical Engineers, with whom the Board of Trade are in communication, and who have already held several important meetings. The two last-named Committees can hardly be said to have got to work as yet, although Mr. TROTTER is now engaged in collecting information to lay before them. We think it will be admitted that this is not a bad record—especially when it is remembered that we are now passing through a period of the greatest activity which the industry has yet experienced, and that the men from whom such Committees are formed are not, as a rule, amongst the least busy.

THE great importance of the question of providing a properly equipped Standardising Laboratory is perhaps scarcely fully realised as yet by the industry at large. It is, however, not too much to say that in the absence of such provision the Electric Lighting Acts will be simply unworkable. In support of this assertion we need only quote two or three of the clauses

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which are common to all Licenses and Orders. Take, for instance, the following clauses:—

"The local authority shall keep all instruments used by them for the purposes of testing any supply of electricity by the Undertakers in efficient working order, and any electric inspector appointed under this Order may, from time to time, examine and record the readings of such instruments at such times and in such manner as he may be directed by the authority by whom he is appointed, and any readings so recorded shall be receivable in evidence." . . . .

"If any difference arises between any consumer and the Undertakers as to whether any meter whereby the value of any supply of electricity to such consumer by the Undertakers is ascertained (whether belonging to such consumer or the Undertakers) is or is not in proper order for correctly registering such value, or as to whether such value has been correctly registered in any case by any meter, such difference shall be determined upon the application of either party by an electric inspector, or where the local authority are the consumers by an inspector to be appointed by the Board of Trade, who shall also order by which of the parties the cost of the proceedings before him should be paid. Subject as aforesaid, the register of the meter shall be conclusive evidence in the absence of fraud of the value of any supply of electricity by the Undertakers to any consumers."

The question immediately arises, *Quis custodiet ipsos custodies?* Who shall standardise the Inspector's standards?

THE Committee of the Electrical Engineers which is dealing with this question is now engaged in drawing up a report showing what has been already done in Berlin, Munich, Hanover, Paris and elsewhere. This report, which will also contain plans and estimates, will be presented to the Board of Trade, and at the same time a deputation will wait on Lord SALISBURY to endeavour to secure his interest in the undertaking. It is, however, evident that no scheme can be considered satisfactory unless the Government are prepared to find adequate funds for the necessary equipment. Building operations will have to be undertaken, and the instruments to be provided must possess every known refinement tending to ensure accuracy, and this cannot be done without money—£10,000 or £12,000 at least will be wanted. There is, however, every reason to believe that in a short time the establishment will become self-supporting. So fully is this belief entertained that an offer was recently made by a private individual to build and equip a standarising laboratory merely as a commercial speculation if the Board of Trade would agree to recognise its work as official. This offer was, however, declined.

AN additional estimate has been issued, showing the amount which will be required during the year ending March 31, 1890, to defray the expenses connected with the acquisition of the Submarine Telegraph Company's property, required for the Post Office service. The total amount demanded is £67,163. A sum of £9,900 is to be paid for the purchase of two cables between England and Belgium, and £18,400 in consideration of four cables between England and France, and the cable between Jersey and France. The acquisition of offices, cable huts, and other buildings and furniture at London, Dover, St. Margaret's Bay, East Dean, and Jersey will absorb £27,413, and the remainder of the total will be swallowed up in fees and the purchase of engines, stores, and the telegraph ship. The telegraph administrations of France and Belgium are to pay £14,150 for one-half share of the property in the cables.

The Gwynne Electric Lighting Company.—We learn that this company has taken large premises in Leather-lane for central station purposes.

Obituary.—We regret to announce the sad death of Mr. C. J. Simmons, the well-known electrical instrument maker, on Thursday, 2nd inst.

Royal Society.—The following Paper was read yesterday before the Royal Society by Prof. E. Hull, F.R.S., "On a Possible Geological Origin of Terrestrial Magnetism."

Elieson Sale.—The piecemeal sale by auction of the Elieson Electric Company's plant, announced in our last issue, is, as will be seen by our advertisement columns, withdrawn until further notice.

Holyhead.—The Holyhead Local Board has resolved to give notice to the Gas Company to terminate the present contract, in order to be able to make new arrangements for the lighting of the town.

Electric Lighting on the Midland Railway.—In a few days the Midland Railway Company will have ready two trains fitted with the electric light. It is intended that they shall run between London and Liverpool and Manchester.

The Danish Cable.—The Fano-Calais cable has been interrupted near the mouth of the Elbe. This is the third interruption in two months, and, says *La Lumière Electrique*, "it is believed that malevolence is not altogether a stranger to these accidents."

Exeter.—The Exeter Electric Light Company has offered, to tradesmen first and private residents next, a supply of light free of charge for two months. Much progress has been made with the work of erecting the machinery at the central station in New North-road.

Telegrams between London and Paris.—On one day the week before last the number of messages between London and Paris despatched between the hours of 11 a.m. and 6 p.m. reached a total of 677, or 97 an hour. These are the highest figures yet recorded.

The Forthcoming Electrical Exhibition at Birmingham.—Mr. T. A. Edison has written to the manager of the Electrical and Industrial Exhibition, which is to be held in Bingley Hall in the coming autumn, that, if his engagements will permit of his leaving America this year, it will afford him much pleasure to accept the invitation of the Executive Committee to visit the Exhibition in Birmingham.

Central Station at London Bridge.—In connection with the London College of Electrical Engineering, a small central station has just been established at Denman-street, S.E. Its operations are at present confined to lighting two Turkish baths and the shops in the railway approach. Permission has been obtained from the owners of the numerous arches with which this part of London is honeycombed to run the cables in them.

A Warning.—On Wednesday evening a fire occurred on the premises of Messrs. Hepworth and Son, at Taunton, which are lighted by arc lights. As an advertisement the lamps remain alight two hours after closing time. About half-past nine on Wednesday evening the goods under one of the lamps were observed to be on fire, but before much damage was done it was extinguished. The fire was caused by a piece of red-hot carbon falling from the lamp upon the goods.

Woodhouse and Rawson (Limited).—It will be seen from the report of the directors of Woodhouse and Rawson (Limited), which we print on another page, that an agreement is to be submitted to the meeting of shareholders to be held this day (Friday), which arranges for the sale of the undertaking to a new company. The scheme met with the general approval of the shareholders at the meeting held on the 14th December

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last. The terms of the agreement will be explained to the meeting, and we understand that the new company will be formed forthwith.

Cables of the Societe Francaise des Telegraphes Sous-Marins.—The following are the cables which belong to this company in the West Indies :—

Aquadores (Cuba) to Caymanera (Cuba)...	50	nautical miles.
Caymanera (Cuba) to St. Nicolas (Hayti)...	126	,,
St. Nicolas (Hayti) to Porto Plata (Hayti)	188	,,
St. Domingo (Hayti) to Curaçoa	453	,,
Curaçoa to La Guayra (Venezuela)	613	,,
Total	980	,,

The Suram Tunnel.—A correspondent writes from Moscow as follows :—"The electric light is in full operation at the above works, which are now making very rapid progress ; a considerable length of the inner brickwork has been completed from the side of Tispu Station and from that of the small town of Bey litz. Heavy falls of snow during the winter had retarded the work, but now that the electric light has been set to work by John Smith and Co., Moscow, under the superintendence of Engineer Tischko. the completion of the works have been taken up with renewed energy and success."

Telephone Trunk Lines in Germany.—At the end of 1888 the number of telephone trunk wires in Germany amounted to 166, having a total length of 10,607 kilometres, and over which a daily average of 28,099 messages were sent. The longest line is that between Berlin and Breslau, which attains a length of 348 kilometres, and over which some 100 messages pass every day. The Hamburg-Lübeck line is the busiest, having a daily average of 390 conversations, the Bremen-Bremerhaven wire coming next with 276 conversations per diem. The authorities have decided to erect 12 additional trunk lines during the current year.

Metropolitan Asylums Board Contract.—The following 13 tenders were received by the Asylums Board for the supply of an electric fire signal system at the School and Asylum for Imbeciles, Darenth, Kent :—Binko and Co , £749. 10s. ; F. J. Lovett, £625 ; Bailey and Grundy, £558 ; Strode and Co., £540 ; Julius Sax, £488 ; Wadley Bros., £473. 8s.; Co., Walker and Co., £438. 8s. ; Harrison and Co., £420 ; Blenheim and Co., £398 ; Fowler, Lancaster and Co., £369. 10s. ; Spagnoletti and Crookes, £348 ; Gent and Co., £333 ; Dale and Co. (Limited), Ludgate-hill, E.C., £318. The tender of Messrs. Dale and Co. (Limited), was accepted.

Royal Institution.—This Institution has recently received two important donations : Mrs. de la Rue has presented to the Royal Institution the philosophical apparatus of the late Dr. Warren de la Rue, which will be preserved there as the historical collection commemorative of the important scientific work of Dr. Warren de la Rue, and of the eminent position he has so long occupied as a promotor of science and of the special objects of the Institution. A fine portrait of Sir Humphry Davy has been presented by Mr. James Young, grandson of the late Dr. James Young, F.R.S., of Kelly, the distinguished chemist and former owner of the portrait. This is a valuable addition to the collection of historic portraits now in the Royal Institution.

Leeds.—At a meeting of the Electric Lighting Committee of the Leeds Corporation, held last week, the borough engineer (Mr. T. Hewson) submitted a report on a scheme for lighting by electricity the central portion of Leeds. He also submitted proposals and other details from two eminent firms who were prepared to contract for the lighting, the line being laid in Boar-lane, Briggate, Vicar-lane, Upperhead-row, and Albion-street. After consideration of the scheme the matter was adjourned for a fortnight to enable the engineer to submit alternative proposals with respect to the arc system of lighting as compared with the incandescent lamps, and as to the greatest distance the light can be delivered from the central station, which is proposed to be placed on the "Midden," at Leeds. The pressure proposed at Leeds is 2,400 volts.

Telegraphic Communication with the Orkneys.—Several meetings of the inhabitants of the Island of Westray, in Orkney, have recently been held regarding the want of telegraphic communication in the island. Westray is the largest of the north isles of Orkney, and has a population of over 2,000. There is an extensive fish trade, one curer alone having an overturn of about £10,000 per annum, large cargoes being shipped to foreign countries. The export of cattle is also great, valued at about £15,000 a year. There is a Post Office, Money Order Office, and Savings Bank, with only two mails in the week, without any telegraphic communication. The adjoining and less important islands of Sanday and Stronsay have telegraph offices. The matter has been brought under the notice of the Secretary for Scotland, the Postmaster-General, and the member for the county ; and it is earnestly hoped by the islanders that telegraphic communication will soon be established in Westray.

Friern Barnet.—At the last meeting of the Local Board of Friern Barnet, Mr. Hennessy proposed that the opinion of an expert should be obtained as to whether there was sufficient spare power in the engines at the Board's sewage works to drive dynamos for the lighting of the district by electricity, and what would be the cost of applying the engines to that purpose. He said the present price of gas—4s. 6d. a thousand feet—was enormous ; and as the machinery was sufficient to deal with the sewage of 40,000 people, and there were only 5,000 people in the district, there would appear to be a great deal of superfluous power. The Chairman seconded the motion on the insertion of a proviso that the expense of obtaining the opinion should not exceed five guineas. The Surveyor, in answer to Mr. Hennessy, said the engines could be used for the driving power for electric lighting if the number of revolutions and the amount of fuel were increased. The Clerk suggested that the opinion of Mr. Baldwin Latham could be obtained free of cost, and Mr. Hennessy agreed to defer his motion until the clerk shall have communicated with Mr. Baldwin Latham.

The Electric Light in Night Attacks.—An important experiment in night attack was made last Friday near Portsmouth, the primary object of which was to ascertain whether by means of the electric light it was possible to see and identify bodies of troops moving in the dark sufficiently well to fire at them. The objective points were Forts Grange and Rowner, forming part of the western defences guarding the land approach to the garrison and dockyard. As a colour test under the electric light, blue coats, red coats, and overcoats of various hues were worn. As soon as the men told off for the attack began to move a powerful beam was projected from the parapet of Fort Rowner, and it thoroughly exposed the positions, notwithstanding that the film of smoke produced by the defenders' own artillery crossed the ray. The red uniforms were very distinct, the least conspicuous colour being blue. What still further contributed to disclose the continually changing positions of the atacking force was the flash of the musketry and the jets of smoke from the firing, which, illuminated as they were under the electric beam, hung suspended like opaque clouds in the air.

Dublin.—The electric lighting License applied for by the Dublin Corporation was issued on May 9. The Corporation are now empowered to erect and maintain electric lines and works, and to supply electric light for "public purposes"—that is for public lamps and to public buildings in the city within the specified districts. There is no power to supply for private use. The following places are included :—Island Bridge-road, Sarah-bridge, Conyngham-road, Parkgate-street, Victoria-quay, Ellis's-quay, Arran-quay, Inns-quay, Upper Ormond-quay, Lower Ormond-quay, Bachelors'-walk, O'Connell-street, Upper and Lower ; O'Connell-bridge, D'Olier-street, Westmoreland-street, College street, College-green, Grafton-street, Dame-street, Parliament-street, Grattan-bridge, Capel-street, Moore-street, Henry-street. Electricity may also be supplied to public buildings along the streets and roads mentioned. Powers are given to lay the mains either overhead or underground, and two and a-half years is the period named for carrying out the project. The Corporation having now attained their object, it remains to be seen what will be done to give effect to the License. The matter will probably be discussed at the next meeting, and some decision arrived at as to the course to be adopted.

The Recent Thunderstorms.—Further details have now come to hand with regard to the numerous accidents and fatalities

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resulting from the severe thunderstorms which occurred at the beginning of the month. Several houses and chimneys were struck in Glasgow and the vicinity. Fatal cases of lightning strokes are reported from Risca (Monmouthshire) and Bletchley. At Portsmouth one of the buildings on Whale Island, intended for the naval barracks, was struck by lightning, which tore off several hundred slates and did considerable damage to the interior of the structure. During a thunderstorm of peculiar severity which visited the Firth of Clyde the sun shone with exceptional brilliancy and the sea was as smooth as glass. Near Shrewsbury a flock of geese was destroyed by lightning. The birds, thirteen in number, were in the centre of a field when they were struck. Several were literally torn to pieces, and some were thrown a distance of sixty yards. At Kingsland (Herefordshire) a police superintendent and some men sought refuge from a storm in a small shed covered with corrugated iron roofing. The building was struck, the superintendent and another man were severely injured, and the contents of the shed, garden tools, axes, &c., were also damaged

Opening of a Central Station at Glasgow.—Messrs. Muir, Mavor and Coulson, who have been lighting the General Post Office of Glasgow and other buildings for some years past, have just formed a company in Glasgow under the name of Muir, Mavor and Coulson (Limited), for supplying light and power from a central station. The Ferranti transformer system is employed. The plant has been laid down in a central station near George-square. The engines, boilers and dynamos are on the ground floor, which has an area of 1,400 square feet. There is at present fixed a large steel boiler working at 100lb. pressure, and a compound horizonal tandem engine of 200 indicated horse-power driving a Ferranti dynamo capable of lighting 3,000 lamps of eight candle-power. There is accomodation for two more similar boilers and engines. An auxiliary engine of 50 indicated horse-power has also been erected, together with a Siemens alternating dynamo capable of lighting 500 lamps. At present, therefore, the installation can supply 3,500 eight candle-power lamps. Sir William Thomson's newest measuring instruments are used. Among the more important undertakings of the Company we may mention the contract with the Corporation of Glasgow for lighting the new municipal buildings, where 1,100 16 candle-power lamps will be fed from the station. Consumers can be supplied by meter at the rate of 8d. per 1,000 watt-hours. Considering the cheapness of gas in Glasgow, we congratulate the Company upon having made such a good start

The London Central Subway Bill.—The Bill for the construction of an electric railway subway between Holborn-circus and Piccadilly came before a Select Committee of the House of Commons on Thursday last week.

Mr. Littler, Q.C., said that the resonance feared from the large quantity of metal used in the construction of the subway would be removed by the use of a material known as fer-flax, composed of iron and vegetable fibre shreds, which would be compressed and packed as panelling between the metal pillars of the subway. Galleries would be provided for pipes and wires. The carriages would be long cars on the American system, each holding about fifty passengers. A system of deflecting plates would keep a derailed train going along until stopped by the brakes, which would be magneto-electric. The trains would run every two minutes, and at a greater speed than on the underground railways. Contractors were prepared to construct the subway for £350,000. Colonel Hazard, one of the promoters, was examined, and the committee adjourned.—On Monday evidence for the promoters was continued, Mr. Harrison Hayter, C.E., in the course of his examination, stating that the width of each train would be 8ft. 2in., the cars being of a size to give 6in. clearance on each side and above, and, acting thus as a piston, would insure ventilation without the blowholes to which objection had been raised in the underground railways. He was of opinion that the subway could be constructed well within the estimates. On Tuesday the Bill was further considered, the evidence of engineers in support of the scheme being proceeded with. The engineer to the scheme, Mr. Knight, said that the electrical motors would be used at each end of the train, one pulling and the other pushing. They would be able to go up to twenty miles an hour in speed, but the average would be twelve. Mr. R. E. Crompton, Dr. Hopkinson, and Sir William Thomson gave evidence in support of the scheme being practicable in their opinion. Mr. W. H. Preece said that the current in the mains would not interfere with the telephonic and telegraphic wires, and the galleries proposed for them would be ample and convenient. Evidence was given as to the working cost per train-mile being about 1s. 6d. Mr. Pope, Q.C., then announced that evidence in opposition would be called by the London County Council.

The Halifax and Bermuda Cable.—In the House of Commons on Thursday last week Mr. Jackson moved that the contract for the construction of a submarine telegraph line from Halifax to Bermuda be approved. The question, he said, had been considered by successive Governments, and all had agreed in the necessity of establishing telegraphic communication between Halifax and Bermuda. The House, therefore, had only to consider whether the terms of the contract were such as should be accepted. The Government had taken unusual precautions to provide for the ample and complete security, not only of the construction, but of the maintenance of the cable. The subsidy of £8,100 which it was proposed to pay would only be payable from the time when the cable was first in working order, and only as long as it was so maintained.—Dr. Cameron moved an amendment to the effect that the telegraphic communication between Halifax and Burmuda would have been better and more economically established by means of a cable to be laid down and maintained by Her Majesty's Government. It was stipulated in the contract that the capital of the company should be at least £100,000, and that the amount expended in laying the cable should be not less than £80,000. But the sum they were asked to pay (£8,100) represented, if capitalised at 3 per cent., a capital of £230,000 or £240,000. The fact was they were undertaking to pay a perpetual subsidy which represented a capital of £250,000.—Mr. Henniker Heaton believed that the contract as such was a good one. But his objection to the proposal was that the British Government should cease paying subsidies.—Mr. Jackson said if the amendment were adopted it would involve the Government in an additional cost of at least £5,000 a year. With regard to the question of rates, the Government messages were to have priority over all other messages at rates to be sanctioned by the Treasury. He believed that the usual rate was 4s. a word.—After some further discussion the amendment was lost and the original motion was agreed to.

Passenger Telpher Lines.—We are informed that the United Electrical Engineering Company (Limited) have just closed a contract with the Mines and General Telpher Company (Limited) for the equipment of a Telpher Line to convey visitors from the Wood Green station up the hill to the Alexandra Palace. The Palace seems to have entered upon a prosperous era, and it is confidently anticipated that the coming season will be a specially successful one. The Wood Green entrance is that by which a very large proportion of the visitors enter the grounds, and the line is for the purpose of conveying them from thence to the Palace and back. The simplicity and economy of electrical traction, our correspondent says, "is likely to cause very great extensions in the equipment of light railways and tramway lines between towns and outlying suburbs and villages which are not yet provided with carrying accommodation; and the great practical development of telpherage initiated by the Palace Line will doubtless command for the system a very great deal of attention. Even in the United Kingdom, where transport requirements may be said to be much better provided for than in other countries, a considerable amount remains to be done. A glance at the maps of either of the three kingdoms will show that large tracts of productive country are unprovided for, so that producers and the travelling public are placed at a considerable disadvantage in competing with those who are more fortunately situated. As has been pointed out by Mr. A. R. Bennett in respect to Scotland, it would certainly not pay to open up most of these districts by means of the ordinary steam railway, even if single tracks and light engines were adopted, but they might profitably be exploited by means of Telpher lines or electric tramways laid either on the public roads or close beside them. In the case of the Colonies and abroad of course the field is enormous, and it would seem that the Telpher system may be a powerful factor in leading to the development of countries which either do not possess capital enough to build railways or even to make common roads, or have not sufficient traffic to justify a large expenditure."

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THE EDISON EXHIBIT AT THE PARIS EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT).

PARIS, *May* 15, 1889.

The Edison exhibit forms a most important and attractive display, the more so as it is already practically complete. No one who examines this remarkable display can fail to be struck with the wonderful versatility displayed in the inventions of Mr. Edison. That one man alone should be the originator of no less than 493 patents, besides the 300 more applications for patents in his name which are still pending, is marvellous enough, but the wide range of applications covered by the patents is still more astounding. The exhibits comprise the most recent apparatus in all the leading branches of Mr. Edison's inventions, and may be classed under the following heads:—Telegraphic, Telephonic, Phonographic, Physical, Electric Lighting, Underground Conductors, Lamp Manufacture, the Electrical Separation of Metals, and Electric Meters. We will first take a rapid glance at the principal objects of interest, deferring a more detailed examination until a later date.

In the Telegraphic Section we find at work the latest bridge quadruplex system, now adopted in this country; the Duplex system, the Phonoplex system of signalling, in which a form of telephone is used as a sounder; train telegraphs, the automatic telegraph, by which a speed of 1,500 words per minute has been obtained. The last-named instrument is capable of transmitting either Roman letters or Morse characters, the former requiring five and the latter three wires. The five-wire system is the most generally adopted, the message being put into the transmitter by a punched slip moving over a metal roller. The roller is rotated rapidly by an electric motor, and the contacts between the battery and line are made through the perforations in the slip. At the distant end the currents produce by chemical action corresponding symbols to those transmitted. This system was operated for some years between New York and Philadelphia and New York and Washington by the Automatic Telegraph Company and the Atlantic and Pacific Telegraph Company; and later, upon the absorption of these companies by the Western Union, it became the property of the latter. There are also exhibited the Harmonic Telegraph, Stock Printers, District Messenger System, Motograph Relay, Carbon Relay, and Rheostat. The motograph relay, which operates a local sounder or Morse circuit, is a marvel in itself. The contact closing the local circuit is attached to a spring resting on a rotating chalk cylinder, and the principle of the reduction of surface friction between the spring and the cylinder on the passing of a current through them, which was applied by Mr. Edison to his loud-speaking telephone, is here applied, the spring responding in lateral movement to the successive currents received. The cylinder is driven by a small electric motor with worm gearing, rendering the instrument, therefore, self-contained. In illustration of the same principle we find several instruments in the Physical Section which have been made specially for the show, amongst which we may mention one in which the experimenter holds a brass spring with a palladium tip, and slides the tip along a surface composed of blocks of various metals in succession. The current being passed through the metallic surface and the spring, a difference can be felt in the surface friction according to the different metals in contact with the spring. In this Section also there are experimental incandescent lamps fitted with a central platinum wire between, but not touching the sides of the carbon filament, to show the "Edison effect," which is, that while the lamp is burning, a galvanometer, or even a sounder, inserted between the positive terminal of the lamp and the isolated platinum wire is actuated every time the sounder circuit is closed. In this Section is also shown the megophone, which is an apparatus for concentrating waves of sound and rendering speech possible at a distance of three miles. There are two large cone-shaped receivers, 7ft. long, and tapering down from 2½ft. diameter at one end to 1in. at the other. A speaking-trumpet, with an orifice 6in. diameter, is fixed between the two receivers.

In the Electric Lighting Section is exhibited a complete central station plant on the three-wire system. Everything will be installed according to the latest methods. The two similar dynamos to be run with this station are each of 125 volts and 240 amperes, and run at 1,200 revolutions. Each machine weighs 4,340lb. The machines are shunt-wound, and can be regulated as to their potential by an adjustable resistance inserted in series with the shunt wire. The three mains, or "omnibus" wires, are conducted from the machines to the distributing board, whence the connections to the various feeders are made.

These details of the central station system really demand separate treatment, and we must defer our description until we can enter exhaustively into the subject with the aid of diagrams. For the present we may say, however, that the underground conductor system is very fully shown, the conductors leading from the central station actually being laid down in pipes according to the latest method. Mr. Edison's original method was to inclose the bare copper mains in iron pipes, and retain their distance apart by passing the mains through pieces of thick millboard placed at intervals along the pipe. It was found, however, that it was necessary to connect together the millboard supports by string, in order that they should retain their relative positions during the running in of the insulation compound. The improvement effected and now employed consists in wrapping each conductor of bare copper round with a separate spiral of rope, which acts as a separator between the mains, and afterwards an outer wrapping of rope round the outside of the conductors, which keeps their position central in the pipe and separates them from contact with it.

The process of lamp manufacture and the Edison electrolytic meter system is shown in great completeness by means of specimens of the actual materials throughout the various stages.

Mr. Hammer, to whom the design of the huge model Edison lamp and the flashing effects in incandescent lamps which are to be exhibited on its pedestal are due, intends, we are glad to hear, to reproduce the marvellous effect of transformation of sound through the medium of two Edison phonographs, two carbon telephones, two motograph receivers, and two induction coils, which he demonstrated with such success at his lecture in the Franklin Institute, Philadelphia, between that place and New York.

I may mention that over the American Section, in the Machinery Hall, an inscription has been put up stating that the United States possess steam engines of 450,000 horse-power, the power of which is transformed into electrical energy; and that, apart from transmission of power, this energy is used to supply current nightly to 2,000,000 incandescent lamps and 250,000 arc lamps.

The conduits which are being laid along the Boulevards from the Porte St. Denis to the Grand Hotel by the companies which have obtained the contract for the lighting of the Boulevards are now practically completed. These conduits are 1·5 metre high and 75 centimetres broad, and are laid under the pavement on either side; transverse conduits under the roadway connect the two lines at intervals. The conductors are uninsulated, being merely suspended from porcelain insulators. The lighting of the Place de l'Opéra commenced the day the Exhibition opened, and that of the chief Boulevards will shortly follow.

The municipal central station at the Halles is progressing rapidly. The foundations for the steam engines are nearly completed, and the chimney is now being built. The Municipal Council have just voted £8,000 for the distributing mains. The President of the Republic has just had an installation of 1,600 10 candle-power lamps put into the Elysée, the current being derived from a 2,000-volt transformer circuit, run from the Edison station at the Palais Royal. The plant devoted to this installation comprises an old type Zypernowski dynamo of 160 horse-power, driven by a Weyher and Richemond engine, besides two 60 horse-power machines. These dynamos are excited by the continuous current supplied by the station. The current is taken to the Elysée by means of a concentric armoured cable, manufactured by the Société Générale des Telephones, and laid partly in a trench and partly in a sewer. The whole installation was executed in a week—a "*beau fait d'armes*," as the daily press terms it.

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THE USE OF THE INTEGRAPH IN DETERMINING SOME PROBLEMS IN ELECTRO-DYNAMICS.

BY L. B. ATKINSON.

(Concluded from page 731.)

The problems treated in the two previous articles have depended on no physical assumptions beyond certain fundamental electrical equations, and their solution by means of the integraph introduces purely kinematical principles. The question now to be considered involves one of the most burning questions of electro-magnetic science; one on which a great deal has been written, and for which many approximate formula have been devised, and it only remains to show that by means of the integraph the question may be probably more nearly solved than in any other way.

The problem is—given a magnetic circuit composed principally or entirely of iron, given also the magnetic force acting, what is the nature of the function which expresses the relation between the magnetic force and the induction?

The formulæ which the most prominent writers on dynamo machine construction have adopted are as follows:—

Prof. S. P. Thompson:

$$H = \frac{G \kappa N C}{1 + \sigma N C},$$

where H is the induction, σ and κ certain constants, and N C the number of ampere turns.

Frölich uses a similar formula:

$$H = \frac{C}{a + b C},$$

where C is the current and a and b certain constants.

Kapp's most recent formula is

$$H = a N C \frac{\frac{\pi}{2}\sigma}{\tan \frac{\pi}{2}\sigma},$$

where a and σ are again constants.

These equations are all used only as approximations convenient from their comparative simplicity for purposes of calculation and graphical representation.

The formula of Lamont rests on certain physical assumptions which, reasonable in themselves, are justified by the fact that the function expressed more nearly corresponds to the facts than any of the preceding. His assumption is this. There is a certain maximum possible induction through any piece of iron. The ratio of magnetising force to induction, or permeability, for every value of the magnetisation depends on the difference between this value and the maximum, or in symbols

$$\frac{dm}{dc} = k(M - m),$$

where M is the maximum value of the induction m.

It has been remarked that the approximate formulæ before given are all reducible to formulæ composed of the first one or two powers of the series into which Lamont's exponential formula can be expanded.

But the integraph described in Fig. 2, *Electrician*, page 702, at once draws the curve expressed by this formula completely, without any approximations. Taking the usual nomenclature of the magnetic circuit, let M be the maximum possible induction, let ρ be the initial magnetic resistance, and m the induction, and n C the ampere turns—

$$m = \frac{\cdot 4 \pi n}{\rho} \text{ F (C) where F (C)} = (M - m) C;$$

hence,

$$\frac{dm}{dc} = \frac{\cdot 4 \pi n}{\rho}(M - m).$$

In Fig. 1 set the bar $b\,b$ at a position such that $h\,o = M$ the maximum induction, set g so that $h\,g = \frac{\rho}{\cdot 4 \pi n}$, then on moving the integraph frame parallel to the axis O X, representing the abscissæ of the current, the integraph wheel follows the curve (m.C) and

$$\frac{dm}{dc} = \tan\theta = \frac{h\,o - o\,e}{h\,g} = \frac{M - m}{\frac{\rho}{\cdot 4 \pi n}} = \frac{\cdot 4 \pi n}{\rho}(M - m),$$

the required curve.

The fact that the magnetic curve can be thus drawn so conveniently suggests the fact that an integrator can be constructed in which the relation of parts is so arranged that the characteristic curve of series or shunt machines could be at once drawn mechanically for any design by proper setting of the parts. It is not worth while here to enter into the details, as the use of such apparatus would be very limited; but a more important application is in the determination of the current in, say, a solenoid with a closed iron magnetic circuit under the influence of an alternating E.M.F. The integraph (Fig. 1) does this when the coefficient of self-induction is constant; but the coefficient of self-induction is not constant. By definition, $\frac{L}{n} = \frac{dm}{dc}$, which has been shown to be expressed by the equation $\frac{\cdot 4 \pi n}{\rho}(M - m)$, and hence the distance $h\,e$ is at any value of x the current proportional to the coefficient of self-induction.

Fig. 7 shows an integraph to draw the curve of current in a circuit enclosing an iron magnetic circuit when the E.M.F. varies according to any law given.

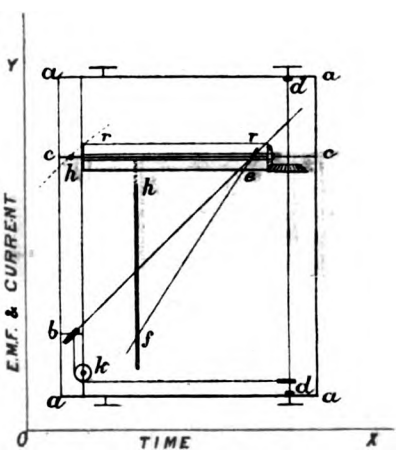

FIG. 7.

$a\,a\,a$ is the frame, b the main integrator and slide; instead of the simple cross-bar of Fig. 1, a cross-slide, $c\,c$, is provided, moving up and down, carrying with it a roller, $r\,r$, which is geared by a pair of bevel wheels, one of which slides with a feather on the shaft $d\,d$, which is driven by the roller d, which has wound on it a cord passing round a pulley and fixed at b, so that the surface of the roller r travels as the frame b moves in the direction O Y, in a ratio fixed by the dimension of d.

The rotating pillar at e instead of being fixed, slides in $c\,c$, being controlled by a second integrating wheel e, guided by a tiller $e\,f$, f being a rotatory point on $h\,f$. (Note.—In the figure, to avoid several lines coinciding, h_1 has been drawn at one side of its true position; h_1 should coincide with h if the self-induction of the wire apart from the core be neglected.)

The initial setting is as follows:—

The pulley at d is of such size that it transmits the motion of b to the surface of the roller r in such a ratio that if $d\,s$ be the element of movement of the surface of the roller,

$$d\,s = \frac{\cdot 4 \pi n}{\rho} \times d\,c,$$

where n is the number of turns in the coil and ρ is the magnetic resistance of the core, $h\,e$ is set equal to $\frac{\cdot 4 \pi n}{\rho} \times \frac{n}{R} \times M$, where M is the maximum possible induction.

Also $h\,f = 1$.

If x be the movement of e from its origin, and $h\,e_1$ the new length of $h\,e$,

$$\frac{dx}{ds} = \frac{h\,e_1}{h\,f} = \frac{h\,e - x}{h\,f} = \left(\frac{\cdot 4 \pi n}{\rho} \times \frac{n}{R} \times M\right) - x;$$

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and if $$x = m \times \frac{\cdot 4\pi n}{\rho} \times \frac{n}{R},$$

$$\frac{d}{ds}\left(\frac{\cdot 4\pi n}{\rho} \times \frac{n}{R}\right) m = \frac{\cdot 4\pi n}{\rho} \times \frac{n}{R} M - \frac{\cdot 4\pi n}{\rho} \times \frac{n}{R} m,$$

or $$\frac{\cdot 4\pi n}{\rho} \times \frac{n}{R} \times \frac{dm}{ds} = \frac{\cdot 4\pi n}{\rho} \times \frac{n}{R} (M - m);$$

but substituting for ds is equivalent value as above, and reducing $$\frac{n}{R}\frac{dm}{dc} = \frac{\cdot 4\pi n}{\rho} \times \frac{n}{R}(M - m);$$

hence $\frac{dm}{dc} = \frac{\cdot 4\pi n}{\rho}(M - m)$, and the curve of magnetisation is satisfied; but $L = \frac{n\,dm}{dc}$,

$$\therefore \quad \frac{L}{R} = \frac{n}{R}\frac{dm}{dc} = \frac{\cdot 4\pi n}{\rho} \times \frac{n}{R}(M - m) = \frac{he_1}{hf} = he_1,$$

and the integrating wheel b follows the curve represented by

$$\frac{dc}{dt} = \frac{bh}{he_1} = \frac{\frac{E}{R} - C}{\frac{L}{R}}$$

which reduces to the equation

$$L\frac{dc}{dt} + CR = E,$$

the current curve, where L has been shown to follow the variation of magnetism with variation of C.

Fig. 8.

One more electrical problem only will be alluded to, though others might be added. Suppose an alternating or variable E.M.F. acts on a circuit (Fig. 8) not closed but connected with a condenser of capacity K through a circuit of resistance R and coefficient of self-induction L. The current equation is

$$L\frac{dc}{dt} + CR = E - V,$$

where V is the potential difference between the condenser plates, and $$\frac{dV}{dt} = \frac{C}{K}.$$

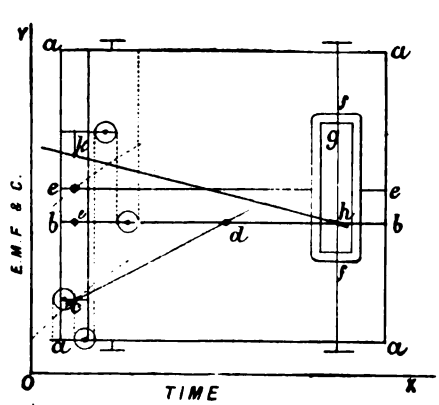

Fig. 9.

Fig. 9 shows the integraph adapted to draw the curve of current to satisfy these equations. The framework $a\,a$ carries the integraph wheel and slide c, and tiller $c\,d$, connected to another slide, whose position is controlled by being the carrier of a second integrating wheel h, which runs on the surface of a roller g. This roller is carried in the frame and slide $e\,e$, which carries the tracer e following the curve of E.M.F. The roller slides on and is driven by the feather shaft $f\,f$ carried by the guide rollers, so that the surface of g moves the same distance as the frame $a\,a$ moves parallel to O X. The curve of E.M.F. and time is drawn to the scale $e = \frac{E}{R}$.

The integrating wheel h is guided by the tiller $h\,k$, k being a point moving with the point c, so that $k\,b$ equals the ordinate of c. This movement is effected by two pairs of pulleys and a cord, as described in an earlier example.

The setting of the parts is thus $l\,h = K\,R$, $l\,d = \frac{L}{R}$, and h starts on the line $e\,e$.

The ordinate $e\,b$ moves so that $\frac{d}{dt}(e\,b) = \frac{k\,l}{l\,h} = \frac{C}{K\,R}$, and calling $e\,b$, $\frac{V}{R}$ then $\frac{1}{R}\frac{dV}{dt} = \frac{C}{K\,R}$, which satisfies the equation of the potential between the condenser plates.

The wheel c traces the curve

$$\frac{dc}{dt} = \frac{cl}{ld} = \frac{ol - C}{\frac{L}{R}} = \frac{e - eb - C}{\frac{L}{R}} = \frac{\frac{E}{R} - \frac{V}{R} - C}{\frac{L}{R}},$$

or $$L\frac{dc}{dt} + CR = E - V,$$

which is the required curve showing the current variation in the circuit.

These cases chosen will suffice to show the adaptability of integraphs of this class to the solution of a large number of electrical problems perfectly generally, which in the ordinary way can only be solved with readiness in certain special cases, or assuming a very simple law of variation of impressed E.M.F.

ELECTROLYTIC DISSOCIATION.

ANSWER TO MESSRS. J. BROWN AND O. LODGE.

BY PROF. W. OSTWALD.

In *The Electrician* of the 19th of April, 1889, there appear two attacks on a Paper by me concerning electrolysis. In the first place Mr. J. Brown objects to the term "free ions," because Faraday's views about their motion during electrolysis were different from mine. At present, however, by "ions" is quite generally understood those parts of the electrolytic molecules which on the passage of the current move in opposite directions. I assume with Arrhenius that these parts are separate from each other in an electrolytic solution, even when a current is not passing, and call them consequently *free* ions. This seems to me to sufficiently denote the difference between my conception and the older one.

As for the experiment to which Prof. Lodge draws attention, I may shortly refer to the history of the whole matter. In the discussion which followed the publication of the theory mentioned above, the objection was often raised that it was impossible to admit the existence of (*e. g.*) free potassium atoms in a solution of potassium chloride. To refute this objection I described an *ideal experiment*, the same to which Prof. Lodge refers. If he had troubled himself to give a translation of the *whole* passage in my Paper (*Zeitsch. f. Phys. Chemie*, 2, 271, 1888), he would not have fallen into the error of mistaking a mere *scheme* used for the purpose of demonstration for an experiment actually carried out.* The passage in question begins with the words, "To get a clear idea of the conditions which here obtain we may imagine the following 'self-evident' ('*selbstverständlich*') experiment carried out. Two vessels," &c., &c.

With the same irritation with which Prof. Lodge charges me with scientific immorality I might bring a similar charge against him, for it is surely no less "a matter of simple morality" to acquaint oneself previously with the contents of a

[*As will be seen from a letter in our correspondence, Dr. Lodge has independently discovered the fact here pointed out by Dr. Ostwald.—Ed. *E.*]

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Paper against which one has entered into a polemic than it is to describe one's experiments with exactness. However, I will not return like for like, but willingly assume that I have not expressed myself sufficiently clearly for Prof. Lodge.

It may be asked if I was justified in describing such an experiment as self-evident. If, first, it be assumed that the laws of electrostatics apply to electrolytes, and, secondly, if the correctness of Faraday's law is granted, then it appears to me impossible to deny the presence of an excess of potassium atoms in a positively charged solution of potassium chloride. Prof. Lodge has questioned neither of these premises, and so will surely accept the conclusion drawn from them.

Besides, an experiment completely comparable with the above scheme has been executed by Soret, and is described in a generally accessible work (Wiedemann's "Elektricität," 2, 469). I confess that I neglected to mention this expressly, and did so because I believed that my two premises were so beyond all doubt that further experiments for their confirmation were not necessary. The last thing, however, that I should have expected was that Prof. Lodge, who has devoted himself with such success to the study of electrolysis, should be in ignorance of this experiment.

Prof. Lodge is thus perfectly right when he declares his conviction that the experiment has not been carried out in the form given by me. But he might have come to the conclusion in a much shorter way, namely, by carefully reading my original communication. Though not done in this form, the experiment has nevertheless been performed in a perfectly equivalent one, and if Prof. Lodge wishes it I will describe to him with pleasure an arrangement by means of which the experiment may be successfully executed in a form corresponding to the scheme.

As doubts were also elsewhere raised as to the absolute validity of Faraday's law, I made, along with Dr. Nernst, some experiments which have proved these doubts to be utterly without justification. I send a copy of the Paper to the editor of *The Electrician*, and should be thankful if in the interest of the matter a translation were published in that journal.*

A word in conclusion to Mr. J. Brown (of Belfast). I have endeavoured to penetrate into the mechanism of electrolysis by studying the movements of the electricity and its ponderable bearers, the ions. Mr. Brown finds this analysis unnecessary, for, as he says, the separation of the ions in the experiments described by me is caused "by the usual electrolytic phenomena."

Mr. Brown (of Belfast) has solved the problem of electrolysis: according to him electrolysis is—electrolysis.

Leipsic, May 3, 1889.

THE PHYSICAL SOCIETY.

At the meeting of this Society, held on the 11th inst., Prof. O. J. Lodge, F.R.S., read a Paper

"On an Electrostatic Field, produced by Varying Magnetic Induction."

Prof. Lodge observed that in common with other experimenters he had often tried to find some connection between static electricity and magnetism, and to illustrate his ideas on the subject he described the following experiments, selected as typical examples from a large number which had suggested themselves to him as likely to throw light on the question :—

1. Spin a long bar magnet on its axis; suspend in its field a sort of quadrant electrometer needle charged oppositely at either end, and look for a deflection.

2. Construct a cylindrical or drum-shaped horse-shoe magnet resembling a pair of iron wheels joined by their naves and wound with wire, spin it on its axis, suspend a charged pith ball between the two rims, and observe what effect, if any, is produced on the ball.

3. Use a varying electro-magnet instead of a moving magnet (an idea for which the author was indebted to Prof. Fitzgerald), suspend some electrified substance—as, for example, a charged gold leaf—between the pole pieces, and see if the leaf moves backwards and forwards when the current is stopped and started.

Prof. Rowland's classical experiment of deflecting a magnetic needle by means of a rotating charged disc, which he has recently repeated so successfully, can hardly be considered to establish a connection between electrostatics and magnetism. What he has shown is that convection currents of electricity exert magnetic effects like any other electric currents. The experimental results which the author was looking for would not, therefore, be exactly the converse of Rowland's experiment, but would be closely related to it. He was in hopes of being able, by some such method as those indicated, to obtain a crucial criterion between Maxwell's theory and some of the contemporary German theories.

The author stated that when Mr. Chattock became a demonstrator in the physical laboratory of University College, Liverpool, two years ago, he found that he was interested in the same subject, and that his ideas with regard to experimenting on it were more practical than his own. Mr. Chattock considered that it was unnecessary to suspend the charged body in a magnetic field, and that varying magnetic induction in a region near the charged body was all that was required. He suggested the use of a closed magnetic circuit, including all its lines of force within itself, and that the charged bodies should be hung outside and close to the circuit, so that as long as the magnetic induction was steady no lines of force would pass through the charge, but when it varied they would move past the charged body, and possibly produce the desired effect. The theory of the results under consideration is as follows :—

If I is the magnetic induction through a circuit the E.M.F. excited in the circuit when I changes is $E=\frac{dI}{dt}$. Now, if an E.M.F. acts on a body carrying a static charge, Q, at a distance, r, from the centre of the solenoid, the work done in making it take one turn is $EQ=F.\,2\pi r$, where F is the mechanical force exerted on the charged body. If, however, the E.M.F. is of the form $\frac{dI}{dt}$, it will only last for a very short time, and we must therefore consider the impulse of the force, namely,

$$\phi=\int_0^\infty F\,dt=\frac{IQ}{2\pi r},$$

and this is the momentum generated when the magnetism of the solenoid is excited or allowed to die away.

This, therefore, or some multiple of it, is what is observed in the experiments. Now with the usual notation,

$$I=\frac{4\pi n C A \mu}{l}=\mu l\times \text{a length, and } Q=KV.$$

Thus the product IQ contains the factor μK, which is the reciprocal of the square of the velocity of light. It follows, therefore, that the observed effect must necessarily be extremely small. Prof. Lodge then observed that in a Paper read before the Society of Telegraph Engineers two or three years ago,* Prof. George Forbes, in considering analogies between magnetic and voltaic circuits, had given almost exactly the arrangement which he had found successful as a magnetic analogue to the tangent galvanometer. Dr. Lodge then described the experiment in the form in which he had last made it.

He takes a large hank of iron wire, weighing some 28lb., covers it with tape, and winds it over with No. 14 silk-covered copper wire, which is then connected through a reversing key with a storage battery or series of ordinary cells, preferably the former. At the centre of the ring is placed a glass vessel containing a delicately suspended apparatus consisting of two oppositely charged conductors of aluminium foil, connected with each other and with a mirror by an arm of shellac. The reversing key is then worked by hand at the same rate as the natural period of vibration of the suspended arm, so as, if possible, to get up a swing. After carefully eliminating electrostatic effects, it was found that with this apparatus no sensible effect of the kind sought for could be obtained.

In his further attempts the author experienced a great deal of difficulty from the substance employed for the conductors being invariably found to be slightly magnetic, and from Foucault currents being set up in the mirror. He finally employed as conductors small cylinders made of thin gelatine, very similar to that which is used to wrap round crackers; and, indeed, in some of the earlier experiments this material was actually employed.

The Foucault currents in the mirror were partially got rid of by scoring the metallic surface with lines, but in his latest experiments he gave up the mirror entirely and used a pointer and reading microscope. The ring was also made much more carefully, of exceedingly fine iron wire, uniformly wound. The Professor then began to entertain some doubts of the effect of the copper near the needle, and sheet copper was used to screen it off from the wire, and also all over the outside of the arrangement so as to screen off electrostatic action; he then, however, came to the conclusion that when this was done the motion of the electricity in the conductors was of the same sign as that of the electrostatic charge which was being looked for, and therefore the reaction of the charge

[* We hope shortly to publish a translation of this Paper.—Ed. *E.*]

* See *Electrician*, December 17, 1886, p. 129.

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momentarily redistributed on the conductors might possibly mask the direct effect of the E.M.F. acting on the charged body. On the other hand, by arranging a copper conductor so that the effect of electric charges induced in it by the E.M.F. should assist the direct effect of the E.M.F. on the charged body, it appeared very likely that the deflection might be rendered visible. A short wire was therefore wound round the outside of the ring and its ends were brought into the box containing the needle, one on each side of it. A distinct deflection of the kind expected was then observed. Ten turns of wire were then used, and a much more marked deflection was obtained.

The author considers that this method would furnish a good means of determining the value of "v," and "v^2" is actually measured in it. What the author wanted, however, was to observe the effect in a free dielectric without the assistance of the conductor, and he succeeded at last in doing this. All copper screens and everything of the kind were removed. A few turns of thick wire were wound on the ring so as to reduce the slope of potential in it. The wire was then wound symmetrically in two halves, and the far ends were connected to a plug key, so that the observer could work either on closed or open circuit. The middle of the battery was put to earth, so that the potentials of the two halves of the wire might be equal and opposite, and the needle was then adjusted by trial and error, the glass box being pushed in and out of the ring, and the suspended fibre turned by a tangent screw until the electrostatic effect obtained by reversing on open circuit was very small. It could never be got down to zero, and even when small it would not always remain so for long. However, if the circuit was now closed by the plug key the electrostatic effect would certainly be largely reduced, and the effect looked for might possibly be seen. This was found to be the case.

The spot of light oscillated over 2 or 3 millimetres when the key was worked in unison with the vibrating arm, so as to assist the electrostatic effect. When the charge of the needle was reversed, the deflection was either neutralised or reversed. This reversal of the electrostatic effect affords, in the Author's opinion, conclusive evidence of the correctness of the observation. Prof. Lodge exhibited a hank of iron wire wound over with tape, with several secondaries wound round it, consisting of copper wire of various thicknesses, and of one or several turns, and he showed that when an alternating current was made to traverse the primary copper circuit the amount of current passing was considerably increased when the circuit of one of these secondaries was closed; the reason being that the impedance of the circuit was greatly reduced, becoming, in fact, nearly zero. The heating of the secondary in the case of a single turn of moderately thick copper wire by the currents induced in it was very effectually shown by wrapping round it a little gun-cotton, which was ignited a few seconds after closing the primary circuit.

DISCUSSION.

In the discussion which followed the reading of the Paper—

Prof. FITZGERALD observed that it would be exceedingly difficult to detect experimentally the existence of an effect depending upon $\frac{1}{v^2}$. He suggested that Prof. Lodge should calculate the momentum which ought to be given to the needle according to theory, and compare it with that which he observed. With such small quantities of electricity as were employed in Prof. Lodge's experiments he would have thought the momentum too small to be sensible. He had himself thought over experiments of the same character for many years, and when the subject first engaged his attention he was only prevented from carrying out his ideas by having no means of suspension sufficiently delicate to give any hope of success. Now, however, this was no longer the case, thanks to Mr. Boys. He stated that Dr. Lodge had not exactly grasped his meaning with regard to the motion of a charged conductor—a piece of gold leaf, for example—between the poles of an electro-magnet, the polarity of which was rapidly alternated. He did not think that a body placed in this position would move backwards or forwards as supposed by Prof. Lodge. He expected that it would rotate in its own plane—that is to say, in a plane perpendicular to the lines of force. He observed that some years ago he had pointed out some modifications which he considered ought to be introduced into Maxwell's general equations of the electro-magnetic field. Maxwell gives the equation

$$P = c\frac{dy}{dt} - b\frac{dz}{dt} - \frac{dF}{dt} - \frac{d\psi}{dx},$$

where P is the x-component of the E.M.F., F the x-component of the vector-potential, and ψ the electrostatic potential. Maxwell's equation for the mechanical force acting upon a circuit carrying a current in a magnetic field, viz.:—$X = v\gamma - w\beta - e\frac{d\psi}{dx}$ + a term depending on magnetism,—should be modified by replacing the term $e\frac{d\psi}{dx}$ by eP. This gives the term

$$e\left(c\frac{dy}{dt} - b\frac{dz}{dt}\right),$$

corresponding to Rowland's effect, and $-e\frac{dF}{dt}$, representing the effect which Prof. Lodge was looking for. He pointed out that there was no analogue to this in the magnetic equations, because there was nothing in magnetism analogous to an electric charge or to an electric current. The flow, as it was called, of the lines of magnetic force, was the analogue, not of a current of electricity, but of the flow of induction in a dielectric, and there was nothing in magnetism analogous to a conductor of electricity.

Prof. S. P. THOMPSON stated that since his last communication to the Royal Society he had made an experiment which had not yet been published, and might be of interest in connection with those described by Prof. Lodge. He had wound copper coils upon rings built up of iron wire—Gramme rings, in fact—and caused an alternating current to traverse the copper coil; then, placing an ordinary Bell telephone receiver in the circuit, he had endeavoured to discover conjugate positions of the second ring with respect to the first, in which the telephone in the second circuit would remain silent while the alternate current passed through the first. He had been unsuccessful in this, having only been able to find positions of minimum noise, even in the case of one ring being placed inside the other, with their planes at right angles. He thought that this was probably due to some of the special properties of iron. When a conductor of any kind was placed within the system of two rings at right angles, such as a rod partially threaded through them, or even a brass ball, it caused a disturbance. This he believed to be due to the oscillations in the conductor. If in place of the conductor a closed circuit were threaded through both the rings, such a disturbance would necessarily be set up by the alternating currents generated in it. He had tried the effect of introducing a dielectric, such, for example, as a rod of Faraday's heavy glass, which he had selected on account of its high specific inductive capacity, in the hope of obtaining evidence of the existence of displacement currents, but he had not been able to obtain any sensible effect.

Prof. AYRTON, referring to Prof. Thompson's experiment, pointed out that the greatest care was necessary in selecting the iron for such rings, and also in winding them, in order to obtain a perfectly inclosed field. He had made a number of experiments upon such rings, and found that they often possessed a series of poles, and when tested by means of iron filings were found to possess an external magnetic field.

Prof. FITZGERALD, referring to the same experiment, observed that it would be of great interest to investigate the effect of introducing substances of different specific inductive capacity into a field of varying vector potential. He pointed out that an *a priori* difficulty exists in the ways of observing these displacement currents so long as there is only a single medium present. In this case the displacement currents due to charging a simple point flow uniformly in all directions outwards from the point, and there are no experimental means of detecting the presence of such a system of currents. In the case of a number of points, the resultant currents will be the sum of those due to each, and therefore the same would hold good for any number of points distributed in any manner in space, so that if the medium were of exactly the same kind throughout, displacement currents could produce no magnetic effects, and, therefore, any such effects observed must be due to the currents which carry the charges to the points.

Prof. S. P. THOMPSON suggested that Dr. Lodge might get over the difficulty presented by the fact that all conductors are more or less magnetic by electrifying an absolute non-conductor by allowing an electric wind to play against it.

Prof. LODGE, in reply to Prof. FITZGERALD, stated that it would be very easy to calculate the momentum which was to be expected, and he had done so in a good many cases. The difficulty was to form an idea of the magnitude of the effect actually observed. An arrangement which might possibly give a sensible effect would be to bend an iron rod into a continuous rectangular circuit, wind a primary coil upon one side of the rectangle and a secondary upon the two adjacent sides; then suspend a hollow iron drum, with the unoccupied side of the rectangle placed in a vertical position coinciding with the axis of the drum; connect one terminal of the secondary to the iron core and the other to the iron drum by means of its suspension. If alternate currents were then sent through the primary coil the successive impulses might possibly give a slight rotation to the drum.

Prof. LODGE then read a Paper by himself and Dr. J. L. HOWARD

"On the Concentration of Electrical Radiation by Lenses."

In some of his recent experiments Prof. Lodge had found some difficulty in concentrating electrical radiation of considerable wave length. With waves only a foot or so in length he found that mirrors were quite sufficient. Prof. Hertz's experiments with a pitch prism suggested the use of lenses formed of that or some similar substance. Several substances were experimented upon, and ultimately the cheapest form of ordinary mineral pitch was employed, as it was found to insulate well, and it also had the advantage of possessing a high index of refraction. The lenses were cast in the form of hyperbolic cylinders bounded by a plane perpendicular to the axis of the principal hyperbolic sections. The eccentricity of these was 1·7, this being taken as an approximation to the refractive index of pitch for infinitely long waves. Such a lens should converge a bundle of parallel rays falling normally upon its plane surface to a focal line coinciding with the line of foci of its principal hyperbolic section. Similarly, rays proceeding from this focal line and falling on the curved surface should emerge from the lens as a bundle of parallel rays perpendicular to the plane surface. The plane surface of each lens was about 85 centimetres high and 90 centimetres broad, and the thickness through the vertex was 21 centimetres. They weighed about

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3cwt. each. In making the experiment the lenses were placed with their plane surfaces opposed and parallel at a distance of 180 centimetres. The oscillator, which resembled a "Hertz oscillator" with some slight modifications, was placed along the focal line of one lens so that the electric rays proceeding from it would become sensibly parallel after traversing the first lens, and would therefore fall normally on the plane surface of the second one, and would be converged to its focal line. The distance from the oscillator to the vertex of the lens was 51 centimetres. This corresponded to about a wave length, which, calculated from the dimensions of the oscillator, was 100 centimetres, and according to interference observations similar to those described by Prof. Hertz, 102 centimetres. The direct effect of the oscillator upon the resonator was perceptible at a distance of 120 centimetres in the axial plane (viz., the vertical plane through the focal lines) of the two lenses in the most favourable case, that is to say, when the room was completely darkened and immediately after cleaning the knobs of the oscillator. Under similar circumstances resonance was only just perceptible at the upper edge of the first lens, which was at a distance of 85 centimetres from the oscillator. The resonator was found to give brilliant axial sparks near the first lens as long as it was held parallel to the oscillator; when it was rotated in a plane perpendicular to the axial plane the sparks were observed to decrease in brilliancy and length, and entirely disappeared when the resonator and oscillator were at right angles. When the rotation was continued the sparks reappeared and regained their former brilliancy after rotation through 180deg. When the resonator was placed in the axial plane, and then moved parallel to itself towards the edge of the lens, the sparks gradually decreased. The edges of the lenses on one side were close up to a brick wall about 40 centimetres thick, while on the other side was a passage about 54 centimetres wide between the lenses and the cupboards of apparatus. It was found that on the side nearer to the wall the sparks disappeared altogether at the edge of the lenses, but on the other side they were visible right up to the edge, and then ceased, after which the direct effect alone was obtained. The beginning of sparking as soon as the resonator entered the shadow of the lens was very marked. The radiation was always a little more visible on the side nearer to the wall than on the other side, which appeared to be due to some unexplained action of the wall. The radiation did not appear to undergo any sensible diminution in intensity through traversing the thickness of the lens. The concentration was very clearly shown by the fact that at the plane surface of the second lens, at a distance of 250 centimetres from the oscillator, the sparking was just as intense as the direct effect would be at 100 centimetres. The point of convergence of the rays beyond the second lens was fairly well defined, but the observers were unable to ascertain the existence of any sensible difference in the intensity of the sparking at its focus and at its surface. The intensity within the cone between the second lens and its focal line appeared to be very nearly equal in the neighbourhood of the axial plane, but the edge of the cone was slightly unsymmetrical on account of the disturbance on the side nearer to the wall. There was, however, no room for doubt as to the convergence of the rays to a focus. Beyond the focus of the second lens there were indications of a divergence of the cone of rays, specially noticeable just after the knobs of the oscillator had been cleaned. Some observations were also made after turning the oscillator through an angle, leaving its centre in the axial plane, its direction being inclined to this plane. The results obtained were of the same nature as those previously observed, but the intensity of the effects beyond the first lens were smaller. When the oscillator and resonator were parallel the sparking was always a maximum, and disappeared when they were at right angles. The results were throughout in complete agreement with those of Prof. Hertz.

DISCUSSION.

In the discussion which followed,

Prof. FITZGERALD pointed out that he had shown that the amount of energy radiated from a vibration is proportional to the fourth power of the rate of vibration, and therefore a comparatively large effect would be produced with a small oscillator. With a large oscillator a very small proportion of energy only would be radiated. Therefore, electricians need not be afraid of any serious loss of energy in alternating dynamos from this source. He stated that he had been very successful in using parabolic mirrors for concentrating the electrical radiations provided the knobs of the vibrator were properly cleaned. He would like to know whether Prof. Lodge had observed any alternations in intensity due to diffraction at the edge of the cone. He had been trying to obtain some results with electrical radiations analogous to Newton's rings in the case of luminous vibrations. There was no electrical reflection from a thin sheet of glass, showing an analogy to the black spot in Newton's rings. He had found that electrical rays falling upon a true non-conductor were invariably completely polarised. He was not at all surprised that Prof. Lodge had been unable to perceive any difference in the intensity of sparking at the focus and at the surface of the second lens respectively, for the Hertz resonators, though very effective as indicators, were very unsatisfactory for quantitative determinations, as even when differences in intensity were distinctly observable there were no means of deciding whether or not this was due to the knobs of the oscillator being in a more favourable condition. He found that the reflection from thick walls was somewhat better than from thin ones. He did not agree with Dr. Lodge that mirrors were less convenient than these lenses. He had used parabolic mirrors for concentrating radiations of considerable wave length, but it was necessary to use mirrors of a very large size.

Prof. LODGE, in reply to Prof. Fitzgerald, stated that he had never been able to perceive any fringes. Dr. Howard once thought that he saw them, but could not be at all certain. He remarked that probably his failure with mirrors was owing to their not being large enough, as the only ones he possessed were small.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, May 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 4, The Sanctuary, Westminster.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Optical Torque." By Prof. S. P. THOMPSON, B.A., D.Sc.

SATURDAY, May 18th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "The Origin and Development of Opera in England (with Musical Illustrations)." By JOSEPH BENNETT.

MONDAY, May 20th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture VI., 3. "Heat Engines other than Steam." By H. GRAHAM HARRIS, M.I.C.E.

TUESDAY, May 21st.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Some Recent Biological Discoveries." By Prof. E. RAY LANKESTER, M.A., F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Discussion on "The Treatment of Steel by Hydraulic Pressure, and the Plant Employed for the Purpose." By W. H. GREENWOOD, M.I.C.E. Time permitting, a Paper will be read on "West of India Portuguese Railway and Harbour Works," by ERNEST E. SAWYER, M.A., M.I.C.E. At this Meeting the last Ballot for Members for the present Session will be taken.

WEDNESDAY, May 22nd.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Use of Spirit as an Agent in Prime Movers." By A. F. YARROW.

THURSDAY, May 23rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Chemical Affinity." By Prof. DEWAR, M.A., F.R.S.

FINSBURY TECHNICAL COLLEGE.

7 p.m. Students' Conversazione. Lecture by Prof. SILVANUS P. THOMPSON, B.A., D.Sc., on "Arcs and Sparks."

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. "An Alternate Current Working." By W. M. MORDEY (Member).

FRIDAY, May 24th.

FINSBURY TECHNICAL COLLEGE.

7 p.m. Second Night of the Students' Conversazione.

INSTITUTION OF ELECTRICAL ENGINEERS.

9 p.m. Conversazione at the Royal Institute of Painters in Water-Colours.

ROYAL INSTITUTION

9 p.m. Evening Discourse. "The Solar Surface during the Last Ten Years." By the Rev. S. J. PERRY, D.Sc., F.R.S.

SATURDAY, May 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "The Origin and Development of Opera in England (with Musical Illustrations)." By JOSEPH BENNETT.

PHYSICAL SOCIETY.

3 p.m. 'On a Relation Existing Between the Density and Refractions of the Gaseous Elements and some of their Compounds." By the Rev. T. PELHAM DALE. "On a Water-spray Influence Machine." By GEORGE FULLER. Notes on Polarised Light:—(*a*) "On the Transition Tints of Various Orders." (*b*) "Lecture Illustrations of the Rotation of the Flame of Polarisation." (*c*) "On the Rotation of Circularly Polarised and Non-Polarised Light." By Prof. S. P. THOMPSON, D.Sc. "Terrestial Magnetism as modified by the Structure of the Earth's Crust." By Dr. EDMUND NAUMANN. "Molecular Weight of Caoutchouc and other Colloric Bodies." By Dr. J. H. GLADSTONE and Mr. W. HIBBERT.

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The Electrician.

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SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" *is published a Steel Plate Portrait of the late* MR. C. H. B. PATEY, C.B., *Secretary for Postal Telegraphs.*

A limited number of copies have been mounted on India Paper, and for these early application must be made. Price 1/-, *post free,* 1/2.

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RAILWAY RATES AND THE ELECTRICAL TRADES.

THE Railway and Canal Traffic Act of last session, although not exactly what the Railway Companies desired or their customers demanded, was on the whole a satisfactory piece of legislation, and if administered by the Board of Trade, as we have every ground for believing it will be, in a spirit of fairness to both parties, the causes of dissatisfaction which have existed for many years past are likely to be almost entirely removed. A great deal will depend, however, upon the action of the trades affected by the Act; and it is gratifying to notice that the electrical interests have secured a powerful ally by affiliating themselves with the London Chamber of Commerce. The Report of the Committee of the Electrical Trades Section, just issued, and a copy of which will be found in another portion of this week's *Electrician*, sets forth some of the main points concerning which manufacturers of electrical machinery and plant are invited to express their opinion. More especially is their attention directed to the schedule of classified rates accompanying the Report, in order that any well-founded objections to them for local or special reasons by firms, either represented or not represented by the Chamber, may be embodied in the revision which the Electrical Section will endeavour to bring about.

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No time should be lost in carefully examining the schedule and comparing the existing and proposed rates submitted by the Railway Companies for the approval of the Board of Trade. The Act came into operation at the commencement of the present year; and by the end of February the combined railways had their classified charges ready for inspection. The Act requires the companies to supply a copy to any applicant at a charge of one shilling, so that local firms ought by this time to be aware of any changes which are likely to affect them on the line of railway where they are situated. But the schedule above referred to will, it is thought, cover most of the ground so far as electrical plant is concerned; and for firms who may prefer to act independently an appeal direct to the Board of Trade is still open to them, the time for lodging objections having been extended until the 9th of next month.

The general character of the opposition to some of the proposed rates is briefly indicated in the Committee's Report; but it should be further borne in mind that this mode of correcting excessive charges on the part of a Railway Company is practically the only one available, any opposition in Parliament subsequently being in all probability of no use whatever. The Act provides that the companies shall submit their classified rates and terminal charges for a specified period during which they are open to objections from "all parties whom the Board of Trade consider entitled to be heard," suitable forms being provided under the Act and supplied on application to the Board, or they may also be obtained from the Chamber of Commerce. Obviously the grounds of objection must be not only reasonable but convincing; and the greatest care will have to be taken to so word the protest that the Board—or the Commissioners appointed under the Act—may be justified in deciding adversely to the Railway Company's proposals. The objections having been duly considered, and an agreement with the company arrived at, a Provisional Order embodying the classification so revised will be laid before Parliament in the usual way, and, if passed, will become part of the law of the land, against which there will be no appeal except by fresh legislation.

It is here that the Act of 1888 introduces a radical change in the relations of the Railway Companies with their customers. Attempts at legislating on railway rates have been continually made ever since railways were started; but until now it has always been possible to secure special privileges by mutual agreement, one well-known method being to remove the favoured article of commerce from one class to another for which lower rates prevailed. The rates were fixed, but the schedules were capable of manipulation. This will no longer be possible, the companies being bound by their classification to charge neither more nor less for the same or similar services than they are entitled under the Provisional Order. At first sight this hard and fast rule may seem disadvantageous to the customer; but one of the gravest complaints which has long been urged against the companies was that they granted preferential rates in their own interests often to the detriment of local industry, and always inimical to free and fair competition. It is believed that the present Act will do away with that injustice; and if it does so, lower rates ought to prevail all round; for it is evident that if the company allowed one class of goods to be carried at artifically low rates, other classes of goods were excessively taxed to make up the loss. Should any case of this kind be suspected under the operation of the new Act, the interposition of the Board of Trade can be invoked, and its decision as arbitrator will be final.

Another way in which the Railway Companies could impose rates which are technically described as "unreasonable" was in certain cases to increase the terminal charges—charges for loading and unloading, station charges, and charges for cartage. These were lumped together with the carriage rates, so that it was always possible to prove that the latter, if questioned, had not been exceeded, by increasing the balance due in respect to the other charges. These charges differ, of course, under differing circumstances, depending upon distance, speed, character of service, and so forth. Such reasonable variations are permissible under the recent Act, and are embodied in the classified lists now being considered; but under the Traffic Act of 1873 the only remedy against unfair usage in respect to terminal charges was by an expensive legal process, whereas the Act of 1888 provides summary process before the new Railway Commissioners who are created under the Act. The fact, however, that the companies are required, in the first instance, to define the nature as well as the amount of all terminal charges, will no doubt tend to obviate disputes of this kind in future. We have stated above that a classification cannot be altered, after it is approved by Parliament, without a fresh Act; but the Board of Trade has the power to add articles of merchandise omitted from the classification, and to class them at its discretion. This fact is of importance to electrical industry, as certain articles have been omitted from the list submitted by the Railway Companies; and it will be one of the first duties, among others, of the Electrical Section of the London Chamber of Commerce to see that they are inserted on "reasonable" terms.

THE CENTRAL STATION DISTRIBUTING MAINS AT BARMEN.

We are indebted to Messrs. W. F. Dennis and Co. for the following very interesting description of the method of laying the distributing mains in connection with the Barmen central station.

The year 1888 has witnessed the introduction of the electric light by central stations in a number of German towns, amongst which the town of Barmen is conspicuous, not only for the quality and soundness of the work done and for the arrangements, which are peculiar in many respects, but also on account of the special difficulties which the hilly character of the country presents to all underground work (there are steep hills on both sides of the River Wupper, with numerous crossings of that river and the "mill creek").

The general installation (buildings, steam engines, dynamos, accumulators, &c.), *see* Fig. 7, has been furnished by the firm of Spiecker and Co., of Cologne (which has in the meantime been amalgamated with the well-known firm of S. Schuckert, of Nuremberg). The cables have been manufactured and laid by the firm of Felten and Guilleaume, of Mülheim-on-Rhine.

The plant is for the first designed to furnish the current to 2,000 glow lamps of 16 candle-power each by means of two steam engines and four dynamos in combined action with 272 accumulator cells. The buildings are, however, so arranged as to admit of an extension to 6,000 lamps.

Having regard to the general disposition of the streets of the town, it was considered advisable to execute the cable system on the three-wire principle. It consists of—

a. The main cables or feeders carrying the current from the engine-house to conveniently situated points, at which it is divided by means of "main cable boxes." The positive and negative main cables are provided with one, the neutral cable with two, insulated tension wires enclosed under the same covering (*see* Figs. 1 and 2).

b. The distributing cables, which are connected to the beforementioned main cable boxes by means of lead cut-outs, and which at their crossings are connected among themselves by means of lead cut-outs in other boxes called "distributing cable boxes."

c. The house connection cables (*see* Figs. 3 and 4). Some of

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these are connected by lead cut-outs direct to the cable boxes; the others ramify from the distributing cables.

The main cables, positive, negative, and neutral, are 36 in number, with sections of 190, 170, 120, 110, 90, 85, 60, 55 and

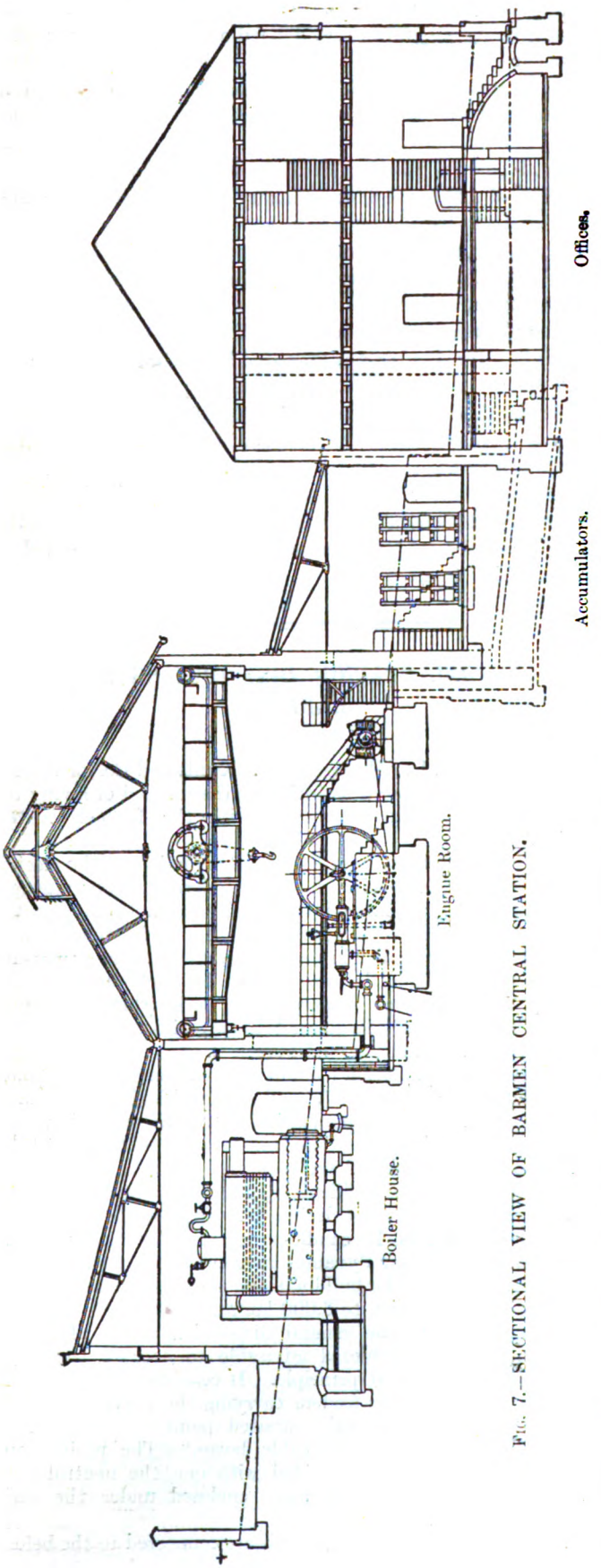

FIG. 7.—SECTIONAL VIEW OF BARMEN CENTRAL STATION.

50 square millimetres, forming a total length of 22,000 metres.

There are 204 distributing cables, with sections of 110, 80, 70, 50 40, and 30 square millimetres, forming a total length of 28,000 metres; and many kilometres of house-connection cables, with sections of 30, 20, 15, and 10 square millimetres.

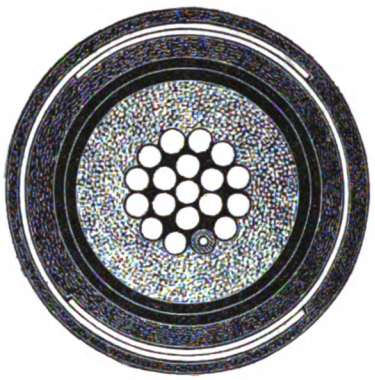

FIG. 1.

The total weight of all the cables employed is upwards of 200 tons.

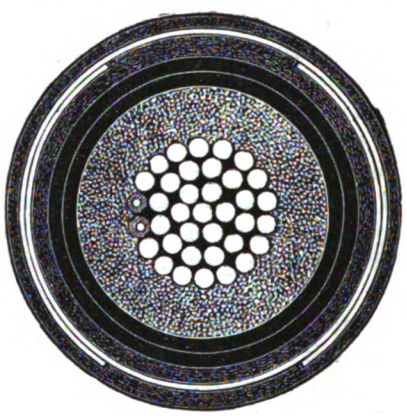

FIG. 2.

The longest distances of the system are :—

1,045 metres to east of engine-house,
1,250 „ west „ and
890 „ south „

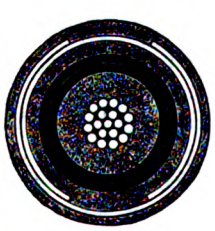

FIG. 3.

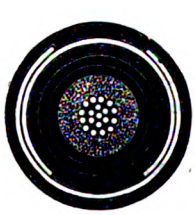

FIG. 4.

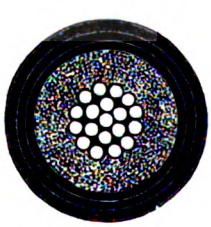

FIG. 6.

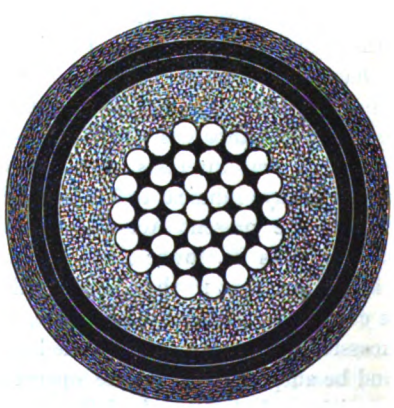

FIG. 5.

The cables are all carefully marked so as to be easily distinguishable in case of repairs later on. They are insulated

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with Felten and Guilleaume's impregnated fibre, and provided with a double lead covering against moisture, as well as a double iron taping against mechanical damage. All cables have been tested under water in the factory at Mülheim-on-Rhine both with regard to conductivity and insulation resistance. They have also been kept under electrical control throughout the operation of laying. After completion the entire cable system, including all cable boxes and house connections, was tested from the central station by means of a delicate mirror galvanometer with very favourable results, exceeding by far the guaranteed figures.

For the purposes of distribution and equalisation of pressure there are in the system 41 cable boxes, viz., 12 main cable boxes and 29 distributing cable boxes. They have been specially constructed for the purpose by Messrs. Felten and Guilleaume according to latest improvements, and are interesting not only for the manner in which they are rendered watertight at the places where the cables enter, but also for the peculiar construction of the current-distributing circles. The brick foundations for the same are provided with a water sink-pit, and have to carry the manhole cover in the street plane. They are so arranged that at any time additional cables can be introduced without having to break up or to make alterations in the masonry.

The whole work of manufacturing and laying the cables took but a few months, while at the same time the firm of Felten and Guilleaume had to make and supply all the cables required for the central stations at Hamburg, Bremen, Lübeck, &c.

A description of the latter installations with regard to the general execution of the same by the firm of S. Schuckert, of Nuremberg, will be found in *The Electrician* of Feb. 8th, 1889. They are different from the Barmen installation in that they are constructed on the ordinary parallel system. Among the cables used in them there are sections of upwards of 600 square millimetres.

The total lengths of cable used in these various installations are as follows:—

Barmen	53,000 metres.
Hamburg	49,000 „
Bremen	21,000 „
Lübeck	21,000 „

All of these are lead covered, but in Hamburg, Bremen, and Lübeck the majority of the cables are not sheathed with ribbon iron (*see* Figs. 5 and 6), but laid in iron troughs with strong iron covers. Also in Hamburg the tension wires are not laid up in the main cables, separate small cables being used.

The experience gained by several years' use of Messrs. Felten and Guilleaume's impregnated fibre insulated and lead-covered cables speaks greatly in their favour. It may be mentioned that Messrs. Felten and Guilleaume also produce by the same process telephone as well as telegraph cables, both subterranean and aerial, of which a total of upwards of 1,500 kilo metres have left their works up to the present, and are in use in all parts of the world.

ELECTRICAL TRADES SECTION OF THE LONDON CHAMBER OF COMMERCE.

REPORT ON RAILWAY RATES.

The following is the report of the Sub-Committee on Railway Rates:—

To the Committee of the Electrical Trades Section of the London Chamber of Commerce.

Gentlemen,—We have carefully considered the provisions of the Railway and Canal Traffic Act, 1888, and have examined most of the proposed classifications of merchandise traffic and schedules of maximum rates and charges submitted to the Board of Trade by the various railway companies in pursuance of the provisions of the above Act. We have also carefully compared these proposed classifications, in so far as they affect goods with which the electrical industry is concerned, with the Railway Clearing House General Classification of goods at present in force; the schedule to this report contains a comparative statement of the existing and proposed classifications of such goods.

The proposed revised classifications were submitted by the railway companies to the Board of Trade in February last, and the Board of Trade have extended the time for receiving notices of objections till the 9th June next.

The category in which an article is placed determines the rate at which it is to be conveyed, and hitherto a revision of a rate was obtainable by a transfer of the article from one class to another. The classification to be made by the Board of Trade will, however, be permanent, and will be unalterable when once adopted by Parliament except by a new Act.

With certain exceptions the Companies in the revised schedules adopt the Clearing House classifications. The signs have, however, been varied:—

Class M (*a*) of Clearing House corresponds to Class A of Revised Classification.

Class M (*b*) of Clearing House corresponds to Class B of Revised Classification.

Class S (special class) of Clearing House corresponds to Class C of Revised Classification.

Class 1 of Clearing House corresponds to Class 1 of Revised Classification.

Class 2 of Clearing House corresponds to Class 2 of Revised Classification.

Class 3 of Clearing House corresponds to Class 3 of Revised Classification.

Class 4 of Clearing House corresponds to Class 4 of Revised Classification.

Class 5 of Clearing House corresponds to Class 5 of Revised Classification.

Classes A and B are not of special interest to the electrical trades.

The classification in Class C applies only to quantities of two tons or upwards; if goods in Class C are sent in consignments of less than two tons they are subject to the maximum and terminal charges in Class 1.

The rates in Classes 1 to 5 apply to quantities exceeding 560lb., an increase of 60lb. on the minimum usually fixed in the existing Acts.

Insomuch as all the railway companies whose proposed classifications we have examined have adopted a common classification, we do not think it necessary in the annexed comparative statement of existing and proposed classification to do more than mention one company—the London and North-Western Railway Company.

Upon reference to the annexed schedule it will be observed that the most serious variation in the proposed classification is the *entire omission* of the item "Dynamos and electric machinery," which, as the result of much effort, it will be remembered, was some time back transferred into Class 3 y when not packed, and Class 2 when in cases. The effect of this omission might be that electric machinery might be classed either under "machines fitted up or partly fitted up not otherwise provided for," not packed, Class 4; packed, Class 3; or under Class 5, the highest category, by being brought under the general definition of "all articles, matter and things not hereinbefore classified."

Although this is the most important objection to the proposed classification, which in our opinion should be strongly raised in the interest of the whole industry, there are no doubt several other modifications which can be shown to be unjust and unreasonable.

The classifications call for the most careful consideration of the various branches of the industry, but care should be taken not to multiply needlessly the objections to be raised. For instance, although "storage batteries" have been removed from Class 2 to Class 3, they can still be conveyed at Class 2 rates by being declared as "electric accumulators."

Other objections, again, as that to the placing of empties in Class 5, will no doubt be made by the Chamber on behalf of all trades.

There are a variety of other questions arising out of the provisions of the new Act, and of the proposed schedules of maximum rates and charges, and of the general conditions submitted by the railway companies, which merit the attention of manufacturers and traders in the country, *e.g.*, the general conditions which are proposed by the companies to govern the traffic, the question of terminal charges, the rates for small parcels, &c., but as these are not of special concern to the electrical industry, we recommend that the Electrical Trades Section should in these matters act in concert with the other Sections of the Chamber.

It would be well, however, for every member of the Electrical Trades Section to obtain the proposals of the railway company or railway companies of his district, and examine and report on such questions as the selection of "large towns" and "terminal stations," which have an important bearing upon the charges the companies will be entitled to make in respect of services before and after conveyance by rail.

[Members of the Section are requested to send in any additional facts interesting to the trade to the Secretary of the London Chamber of Commerce, Botolph House, Eastcheap, E.C.]

The Schedule will be found on next page.

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Schedule of Existing and Proposed Classifications, in so far as they affect Goods appertaining to the Electrical Industry.

Description of Article.	Existing Classification.	Proposed Classification.
Acid, sulphuric	Under 2 tons in the carboys double 4	...
Accumulators, electric	2	2
Angle-plates, steel	For less than 2 tons, 1st	2 tons and up, C
,, ,,	Over, special	less 1
Asbestos	2	...
Bar iron	For less than 2 tons, 1	Less 1
	Over 2 tons, special	2 tons and up, C
Bar iron, puddled	10% over rates for pig iron	2 tons and up, C less 1
Bars, angle iron or steel	S	2 tons and up, C less 1
Bundles of bars—		
Under ⅜in.	1	1
Over ⅜in.	S	1
Capstan	1	1
Cast iron	1	1
Batteries, telegraph	3	...
,, electric storage	2	3
Bed plates, engine	S	2 tons and up, C less 1
Beds and cylinders	1	1
Belting, leather	3	3
Boiler fittings, except loco., and not accompanying the boiler	2	2
When with boiler at same rate as boiler.		
Boilers, less than 1 ton, occupying 1 waggon	2	2
Boilers under 30ft.	1	
,, above 30 and under 45ft	2	
,, above 45ft.	3	
Bolts and nuts, iron	S	2 tons and up, C less 1
Brass	2	2
Bronze (Phosphor) castings and ingot rough	2	2
Cable	4y	4
Carbons	3	3
Canvas belting	3	3
Carboys, not glass, empty, not returned	4	...
Ditto, glass, empty	3	...
Cardboard	1	3
Cardboard boxes, packed, except in cases	4	...
In cases	3	...
ars, Tramway	Miles. Per ton Per ton mile. added. Up to 20 ... -/3 ... 2/- 21 ,, 22 ... 7/- ton. 23 ,, 34 ... -/2¾ ... 2/- 35 ,, 38 ... 10/- ton. 39 ,, 40 ... -/2½ ... 2/- 41 ,, 54 ... 11/- ton. 55 & up. -/2 ton & 2/- add.	...
Chandeliers and gasaliers	5	5
Castings, brass	3	3
,, crank, unfinished	S	...
,, steel	37	2 and 3
,, rough and unfinished	1	1
,, iron, malleable	1	2
,, iron, light, packed	1	2 and 3
Cement	S	Blocks or slabs 4 tons up, B C, 2 tons up, less Class 1
,, and concrete	MB	,,
Cement and composition for retaining heat in boilers, in casks, cases, or bags	S	...
Cement, patent metallic	S	...
Chains, unpacked	S	2 tons and up, C less 1
,, packed	S	2
China, in boxes or cases	4	5
,, casks or crates	2	
,, hampers	3	
Cisterns, cast iron	2y	4
Cisterns and tanks, iron or wooden (not lined with lead)	2	4
Cisterns, wood and lead lined	3	4
Coal	MA	4 tons up, A 2 ,, C less 1
Copper	2	2
Cordage	2	2 ropes
Cotton waste	2	2
Cotton and linen goods in bales, boxes, cases, or trusses	3	3
Coupling boxes	S	...
Crucibles	3y	Clay 2, also 5 2 tons up, C less 1
Cullett	S	...
Delta metal	2	3
Disincrusting fluid	2	...
Dynamos and electric machinery, not packed	3y	...
,, in cases	2	...
Ebonite or vulcanite	3	...
Engines, caloric	2	...
Engines, portable— Lots of over 2 tons	Miles. Per ton Per ton mile. added. Up to 20 ... -/3 ... 2/- 21 ,, 22 ... 7/- ton. 23 ,, 34 ... -/2¾ ... ,, 35 ,, 38 ... 10/- ton. 39 ,, 40 ... -/2½ ... ,, 41 ,, 54 ... 11/- ton. 55 & up. -/2 ton & 2/- add.	2
Engines, lots of less than 2 tons	4y	2
Empties returned and from original consignee to original sender	Not exceeding Per cwt. 25 miles ... -/6 26 to 50 ,, ... -/8 51 ,, 100 ,, ... 1/- 101 ,, 150 ,, ... 1/3 151 ,, 200 ,, ... 1/6 201 ,, 250 ,, ... 1/9 251 ,, 300 ,, ... 2/- 301 ,, 400 ,, ... 2/3 401 ,, 500 ,, ... 2/6 501 ,, 600 ,, ... 3/-	Class 5
Engines, steam	Under 3 tons, 3	2
,, gas	2	2
Fibre, vulcanised	,, 3	...
Files	2	2
Fire bricks	MB	B
Fire boxes of steam engines	2	.....
Fittings, illumination	3	Gas fittings 3 (iron)
Fly-wheels and spur wheels not requiring special vehicle—		
Finished	1	...
At owner's risk	1	...
Unfinished	S	...
Forgings, iron or steel, in the rough	S	2 tons and up, C less Class 1
Frames, almanac, in pieces, packed	3	...
Frames, street lamp	3	3
Furnace boilers	2y	...
Globes, moons and shades	4y	5
Insulators, electric	2	2
Mirrors, packed	5	...
Glycerine, in glass carboys, packed	5	5 Casks or iron drums.
,, not packed, owner's risk	5	3
Gun-metal	2	2
Heaters, expanding feed-water	As boilers	...
Hoop iron or steel	1	1
Hoops, iron, in the rough	S	2 tons up ... C less 1
Hydraulic machinery	1	1
Insulators, telegraph, packed	1	...
Iron, blooms, billets, and ingots, not foreign	10 per cent. over rates for pig iron	2 tons and up, C under 1
Foreign iron	MB	...
Pig iron	MB	4 tons & up ... B 2 ,, ,, .. C under 1
,, Foreign	10s. over rates for British pig	...
Iron, sheet or plate, annealed	1	...
Irons, tue (or tuyeres)	2	3
Lamp-posts, iron	1	1
Lamp reflectors, enamelled iron	3	3
Lamps, except paraffin	4	4
Litharge	1	1
Machines, fitted up or partly fitted up, not otherwise provided for, not packed	4	4
Machines, packed	3	3
Meters, gas	3	3
,, water	3y	3
Mouldings, common wood	3y	...
Oils, Castor, lubricating, in cases	1	2, also 4
Oils and varnish in tins	3	Oils 2 ,, 4
Packing piston	2	...
Paints and colours—		
In cans, hampers	3	In jars, 5
In casks or drums.	2	
In tins, packed in cases	2	2 also 3
Paper, bales or bundles	1	3
,, boxes or cases	3	
Patterns, Travellers', except china, plated goods, and goods chargeable 5th Class rate, packed in boxes, cases, parcels, or hampers	4	4
Patterns, wood	4y	4

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Description of Article.	Existing Classification.	Proposed Classification.
Pipes, brass or copper	4	4
Pipes, cast iron or steel—		
2 tons and upwards	1	1
less lots	1y	
Posts, iron for wire fencing and street boundary posts	S	2 tons and up, C less Class 1
Posts, lamp iron	1	1
,, signal	2	...
,, telegraph	1	...
Pulleys, iron	3	3
Reflectors, glass, with metal backs	4	5
Ropes, new, not wire	2	2
,, wire, new	2y	...
,, ,, old	S	...
Salammoniac	2	2
Screwing Machines	1	1
Shaping ,,	1	1
Sheet iron in bundles, not packed	1	1
Sheet steel	3y	3
Sheet or iron plate, annealed	1	1
Shellac	3	3
Solder and solderine	1	Solder 1 Solderine ...
Spelter or zinc, not packed	S	Spelter 1 ,, sheet 2
Spirit, methylated—		
In hampers	4	*Spirits quoted in cases or casks, Class 3; methylated spirits, also quoted, Class 5
,, casks or cans	3	
,, jars or bottles under 2 gallons	4	
,, ditto over 2 gallons	5	
Sponge cloths	2	...
Stampings, iron rough, unfinished	1	...
Stampings, shearings, and clippings in bundles	S	...
Steel bars or bundles	2	2
Strips, iron, in bundles, unpacked	1	...
Tapes	3	...
Taps, brass or wood	3	3
Tar, except felt tar, gas tar, coal tar, in casks	S	...
Telegraph cable	4y	4
Telegraph clothing—		
Post Office servants (new)	3	3
,, ,, (old)	2	
Telegraph instruments	4	5
,, insulators	1	...
,, poles at machine weight	S	...
Telegraph posts, iron	1	1
Telegraph wire coated with gutta-percha, packed or not	4y	Wire, insulated, 4
Telegraph stores, viz.:—		
Unpacked: W.I. Double Swivels	1	2 tons and up, C less Class 1
Unpacked: C.I. Wall brackets	1	
Unpacked: C.I. Saddles	1	
Unpacked: G.I. & I. Looped rods.. Stay tighteners, &c. ...	S	2 tons and up, C less Class 1
Telephone apparatus, packed	4	5
Tinfoil	2	2
Tools, Edge	3	
Carpenters and coopers	3	3
Joiners and shipwrights	3	
Tram couplings	1	...
Tram wheels	S	...
Tubes:—		
Iron or steel	1	1
Steam, new	2	2
,, old	1	...
Tubing, brass or copper	4	4
Valves, brass	3	3
,, Gas and water, Iron	1y	1
Varnish:—		
In vessels of bottle shape, iron or tin	3	
In cases, packed in cases or protected with iron hoops	3	3
In jars protected by wicker work	3	
In casks or iron drums	2	
In glass carboys or tubs	5Z	
Washers, brass or copper	3	3
,, iron	S	2 tons up, C less 1
,, leather	2	2
Wire:		
Copper or brass, packed in casks, cases, or bags	33	3
Cotton covered, packed	2	Insulated? 4
German silver	3	...
Iron	2Z	1 and 2
,, undamageable	S	2 tons up, C less 1
,, dipped in a solution of copper	3	3

(*) denotes that the article is omitted from the classification.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"On Lightning, Lightning Conductors, and Lightning Protectors."*

BY DR. OLIVER LODGE, F.R.S.

(Continued from page 9, Vol. XXII.)

SUMMARY OF POINTS OF DIFFERENCE AND CONTROVERSY.

39. In may be convenient here to summarise a few of the points wherein the doctrines which I advocate differ from the views held by the older electricians. And the summary will give me an opportunity of emphasising the incorrectness of the older views in many instances.

I quote a few statements prefixed by capital letters from an abstract I made for *The Electrician* after the Bath meeting of the British Association. (See *The Electrician*, September 21 and 28, 1888.)

A. Rods as at present constructed, though frequently successful, may and do sometimes fail, even though their earth is thoroughly good, the reason being that they offer to a flash a much greater obstruction—a much worse path—than is usually supposed—an obstruction to be reckoned in hundreds or thousands of ohms, even for a very thick copper rod. N.B.—This is not resistance proper, but impedance.

I may be permitted here to repudiate the doctrine which has several times been attributed to me since the Bath meeting, that it is safest to be without lightning conductors altogether. The long experience of persons learned in this art is by no means to be despised, and, until an agreement as to improvements has been arrived at, the safest plan for ordinary persons is to adhere to existing practice. Nevertheless, that conductors sometimes fail, is as certain as that they often succeed. My statement is that customary arrangements are not perfect and are susceptible of improvement. The statement of the Lightning-Rod Conference is that "there is no authentic case on record where a properly constructed conductor failed to do its duty." Mr. Preece calls the statement "most decisive." It is certainly *decided*, and in the light of other matter contained in the same red covers I assert it to be in its natural and intended signification decidedly false. The only signification which makes it true makes it also senseless, as if one should record the statement that white things are white. In my Society of Arts lectures I said nothing against the report of the Lightning-Rod Conference, because the work done by that body in collecting information, abstracting papers, and recording instances was obviously very valuable, and much of the report itself is correct; while as for the occasional rash statements in that document I imagined the signatories would wish them to sink into oblivion in silence. But Mr. Preece has revivified them, and conspicuously made himself afresh responsible for them;† accordingly I now extract one or two more sufficiently dogmatic and unfortunate statements from the same source.

"A man may with perfect impunity clasp a copper rod an inch in diameter, the bottom of which is well connected with moist earth, while the top of it receives a violent flash of lightning." "If all these conditions be fulfilled; if the point be high enough to be the most salient feature of the building—no matter from what direction the storm may come—be of ample dimensions, and in thoroughly perfect electrical connection with the earth, the edifice with all it contains will be safe, and the conductor might even be surrounded by gunpowder in the heaviest storm without risk or danger." To adhere to such views as these now, with tenacity sufficient to cause them to be promulgated as authoritative scientific statements, would be, in my opinion, little less than criminal.

"All accidents may be said to be due to a neglect of these simple ele mentary principles." Certainly this "*may be said*," because it already has been said over and over again; but it cannot be said with truth.

Whenever an accident happens, a believer in the modern exponents of the Lightning-Rod Conference who could not point out a flaw, or a bad joint, or a bad earth, or a possible flaw, or a possible bad joint, or a possible bad earth, would feel himself disgraced as a practical man. An instance occurred in quite a recent number of *Nature*. The writer of "Electrical Notes" records that a number of fish had been killed in a pond into which the earth end of a conductor had been led, and concludes with the ejaculation, "When will people learn to make proper earth connections?" I select this instance as typical of the extraordinarily contradictory advice often bestowed on that long-suffering body the British

* Paper read before the Institution of Electrical Engineers on Thursday April 25, 1889.

† Saying at Bath, as a prelude to a quotation from the report, "The report itself is most decisive and most important; there is a true ring about it—the ring of men who knew what they had done and what they were writing about."

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public. Before an accident, the pond would be pointed out as an excellent earth, as indeed it most likely was. After the slaughter of the fish, the erector of conductor is impersonally ridiculed for having utilised it. So with any struck building. After an accident defects *must* be forthcoming, because else there would be "an authentic case on record where a properly-constructed conductor failed to do its duty," which *ex hypothesi* is absurd and impossible; therefore it was not constructed in accordance with the directions of the Lightning Rod Conference therefore it was defective. Q.E.D.

B. When a Leyden jar is charged it corresponds to a bent spring, and its discharge corresponds to the release of the spring. Its discharge current alternates, therefore, in the same way and for much the same reason as a twitched reed or tuning-fork vibrates. The vibrations decay in either case because of frictional heat production and because of the emission of waves into the surrounding medium. A single spark of a Leyden jar, examined in an exceedingly fast revolving mirror, is visibly drawn out into a close succession of oppositely-directed discharges, although its whole duration is so excessively minute.

It is very likely that this statement will now no longer be denied. So I pass to the next.

C. A lightning flash is a spark between cloud and earth, which are two oppositely electrified flat surfaces, and the flash corresponds therefore to the internal sparking between the two plates of a great air condenser. All the conditions which apply to a Leyden jar under these circumstances are liable to be true for lightning. Sometimes the resistance met with, either in the cloud itself or in the discharger, may be so great that the spark ceases to be oscillatory, and degenerates into a fizz or rapid leak; but there can be no guarantee that it shall always take this easily manageable form; and it is necessary in erecting protectors to be prepared for the worst and most dangerous form of sudden discharge. The apparent duration of a lightning flash is due to its frequently multiple character, and indicates successive discharges, not one long-drawn-out one. Nothing that lightning has been found to do disproves its oscillatory character, because Leyden jar discharges, which are certainly oscillatory, can do precisely the same.

This was in answer to Mr. Preece's contention that lightning could not be oscillatory, because it magnetised steel bars and deflected ships' compasses. The next is an antidote to the continually made statement that the one thing needful for an efficient lightning conductor is *conductivity*.

D. Although some conductivity is necessary for a lightning conductor, its amount is of far less consequence than might be expected. The obstruction met with by an alternating or rapidly varying discharge depends much more on electro-magnetic inertia or self-induction than upon common resistance. So much obstruction is due to this inertia that a trifle more or less of frictional resistance in addition matters practically not at all. It is very desirable to have a good and deep earth in order to protect foundations and gas and water mains from damage, and in order to keep total impedance as low as possible.

I find it sometimes thought that I have argued against the need of a good earth. This is not so. I have argued against the exclusive and exaggerated attention that has been paid to this need.

In opposition to the following statements, *e*, *f*, *g*, *h*, *i*, the substance of which may be considered as hitherto orthodox, I make the statements subsequent, labelled *E*, *F*, *G*, *H*, *I*:—

e. No danger is to be feared from a lightning conductor if only it be well earthed and be sufficiently massive not to be melted by a discharge. All masses of metal should be connected to it, that they may be electrically drained to earth.

f. The shape of the sectional area of a conductor is quite immaterial; its carrying power has nothing to do with the extent of surface; nothing matters in the rod itself but sectional area or weight per foot run, and conductivity.

g. Points, if sharp, should constitute so great a protection that violent flashes to them ought never to occur.

h. Lightning conductors, if frequently tested for continuity and low resistance by ordinary galvanic currents, are bound to carry off any charge likely to strike them, and are absolutely to be depended upon. The *easiest* path protects all other possible paths.

i. A certain space contiguous to a lightning rod is completely protected by it, so that if the rod be raised high enough a building in this protected region is perfectly safe.

These statements I say are erroneous. The following I believe to be correct:—

E. The obstruction offered by a lightning rod to a discharge being so great, and the current passing through it at the instant of a flash being enormous, a very high difference of potential exists between every point of the conductor and the earth, however well the two are connected; hence the neighbourhood of a lightning conductor is always dangerous during a storm, and great circumspection must be exercised as to what metallic conductors are wittingly or unwittingly brought near or into contact with it. When a building is struck, the oscillations and surgings all through its neighbourhood are so violent that every piece of metal is liable to give off sparks, and gas may be lighted even in neighbouring houses. If one end of a rain-water gutter is attached to a struck lightning conductor, the other end is almost certain to spit off a long spark, unless it also is metallically connected. Electric charges splash about in a struck mass of metal as does the sea during an earthquake or when a mountain-top drops into it.* Even a small spark near combustible substances is to be dreaded.

F. The electrical disturbance is conveyed to a conductor through the ether or space surrounding it; expressed more simply, lightning currents make use of the periphery of a conductor only, and so the more surface it exposes the better. Better than a single rod or tape is a number of separate lengths of wire, each thick enough not to be easily melted and well separated so as not to interfere with each other by mutual induction.

The liability of rods to be melted by a flash can be easily overestimated. A rod usually fails by reason of its inertia-like obstruction and consequent inability to carry off the charge without spittings and side flashes; it very seldom fails by reason of being melted. In cases where a thin wire has got melted, the energy has been largely dissipated in the effort and it has acted as an efficient protector, though, of course, for that time only. Large sectional area offers very little advantage over moderately small sectional area, such as No. 5 B.W.G.

G. Points, if numerous enough, serve a very useful purpose in neutralising the charge of a thunder-cloud hovering over them, and thus often prevent a flash; but there are occasions easily imitated in the laboratory, when they are of no avail—for instance, when one upper cloud sparks into a lower one, which then suddenly overflows to earth. In the case of these sudden rushes, there is no time for a path to be prepared by induction, no time for points to exert any protective influence, and points then get struck by a violent flash just as if they were knobs. Discharges of this kind are the only ones likely to occur during a violent shower, because all leisurely effects would be neutralised by the rain drops better than by an infinitude of points.

H. The path chosen by a galvanic current is no secure indication of the course which will be taken by a lightning flash. The course of a trickle down a hill side does not determine the path of an avalanche. Lightning will not select the easiest path alone; it can distribute itself among any number of possible paths and can make paths for itself. Ordinary testing of conductors is therefore no guarantee of safety, and may be misleading. At the same time it is quite right to have some system of testing and of inspection, else rust and building alterations may render any protector useless.

I. There is no space near a rod which can be definitely styled an area of protection, for it is possible to receive violent sparks or shocks from the conductor itself, not to speak of the innumerable secondary discharges which by reason of electro-kinetic momentum and induction, by reason of electro-magnetic waves, and of the curious recently-discovered effect of the ultra-violet light of a spark, are liable to occur as secondary effects in the wake of the main flash.

Instructive Extracts from Reports of Damage by Lightning.

40. Reading between the lines of existing reports on damage done, one can frequently find evidence of many of the phenomena to which I have now called attention. Of course they are not recorded in any prominent manner, because they are to the observers ill-understood and puzzling facts; it is very difficult to note what has exactly happened in any given case unless some clue or expectation has been formed beforehand. The bad conductivity clue, which was the only one prominently available to the skilled recorders in the following cases, is a very partial one, and in many cases is quite insufficient to account for the facts without undue pressure being put upon it.

Under such circumstances the record of the facts is, of course, far more valuable than the comments made upon that record; and in the following extracts the theoretical remarks should be eliminated or slurred over.

One minor imperfection, common to many accounts, is that they are not sufficiently alive to the possibility of all manner of branching discharges, so that the discharge is said to leave a conductor and go to something else, when the truer statement would be that some *portion* of it branched off at such and such a point.

In the following quotations the references are usually to the pages of the volume of the Lightning-rod Conference, published by Spon in 1882:—

41. Illustrating Side Flashes and Surging Circuits.

"*L.R.C.*, p. 39.—*J. Murgatroyd. St. Mary's, Crumpsall, near Manchester.*—A lightning conductor from spire touched the eaves gutter, and a gas pipe touched the end of this gutter. The lightning passed from the conductor along the gutter to the gas pipe, melted it, and set the church on fire by igniting the gas."

"*L.R.C.*, p. 39.—*Wyatt Papworth.*—Tall spire struck. The church stands in an open position with no large trees near. It was

* *See* the Report of the Krakatoa Committee.

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provided with an iron lightning conductor ¾in. diam., fixed with iron holdfasts and carried down inside the spire and tower into ground; the top of it was said to be attached to a bold copper finial on the spire about 150ft. from the ground and 50ft. above ridge of roof; the lightning is supposed to have first struck the finial, it slightly deranged some beds of masonry in upper part of spire, then descended by iron rod to belfry, melted a gas tube in the floor, and set fire to the belfry by igniting the gas."

From Abstract of Report on the Destruction by Lightning of a Gun powder Store at Bruntcliffe, Yorkshire. By Major V. D. Majendie, R.A. (L.R.C., p. 77.)

"The gunpowder exploded at 4:30 p.m. on August 6, 1878, during the greatest intensity of a violent thunderstorm. The building was brick, with brick arched roof, length 9f.t, with 5ft., height 6ft. (internal dimensions). The store had a uniform thickness of three bricks, and was furnished at one end with an iron door, at the other end with a lightning conductor. The conductor consisted of a copper wire rope, 10 gauge copper wire, the rope being $\frac{7}{16}$in. thick, having four points at the top (one large one in the centre, and three smaller ones round it); it extended to about 13ft. above the top of the building, and about the same length was carried into the ground and terminated in a drain. The conductor had been erected in 1876 by Mr. John Bisby, of Leeds, and was fixed to a pole distant about two inches from the end of the building opposite to that in which the iron door was fixed (it was not connected with the iron door in any way). No one was near the store when the powder exploded, and it seems probable that [the earth connection of the conductor was bad, that] the mass of iron in the door offered at least an equally good path—and that the gunpowder was ignited by a flash passing between the two imperfect conductors."

To make this report completely scientific, it would be well to omit the words I have put in square brackets.

Extract from a reply of Mr. Baldwin Latham, C.E.:—

"It is no uncommon thing for buildings provided with what are called lightning conductors to be damaged by lightning, and the cause is due to the inadequacy of the conductor to carry the electric fluid, which will leave the conductor for a better or a larger conductor." (*See* also Sec. 43.)

42. As illustrating that a good conductor affords no absolute security, the following document is worthy of reproduction in full, as given in *L.R.C.*, p. 115:—

"*Ueber Blitzableiter und Blitzschläge in Gebäude welche mit Blitzableitern versehen waren. Von G. Karsten. Keil. 8vo. 1887. (Abstracted by R. Van der Broek.)*

"In this pamphlet Dr. Karsten gives an account of two cases in which buildings that were provided with lightning conductors were damaged by lightning. The author states that the statistics for the year 1873 show that in Schleswig-Holstein twenty-six per cent. of all the cases of fire were caused by lightning; $\frac{1}{130}$ part of these cases occurred in the towns and the remainder in the country.

"Do lightning conductors guarantee absolute protection? The author answers this question as follows:—There is no absolute certainty in empirical matters; each new case may direct our attention to circumstances that had been overlooked. If lightning conductors cannot be said to ensure perfect safety, they certainly afford a very high degree of protection.

"The flash of lightning which struck the church at Garding, on the 18th of May, 1877, fractured the conductor in fifteen places, and pierced the wall of the steeple in two places. The inefficiency of the conductor resulted from the carelessness with which it was fixed; the line was laid down the north side of the steeple and fastened with 25 wall eyes; these wall eyes were hammered too deep into the wall, thus damaging the line and forming a short and sharp bend in each case, besides also unduly straining the wire. The damage to the steeple was the consequence of a neglected secondary circuit. There are an excessively large number of tie-rods in the steeple; the heads of these rods are not connected together, neither are they, except in one case, in close proximity to any of the larger masses of metal that are about the building. The conductor passed close to one of those heads; the south side of the steeple, where the opposite head is, becoming wet through the rain, a secondary circuit was formed, and a return shock followed; the damage to the steeple was trifling.

"The rod was provided with a conical point, rather blunt, but surmounted by a short platinum point. The copper line-wire was of good material—not of a uniform thickness, but at the weakest places not weighing less than 240 grammes per lineal metre (8oz. per yard, or rather less than ¼in. diameter if solid). The earth-plate was sunk into a well 10 metres deep, and tested faultless after the discharge."

43. The following series of notes are better not separated, though they bear upon different points:—

L.R.C., p. *93 et seq.—From Abstract of Statistics of Buildings and Ships struck by Lightning. By F. Duprez, Member of the Academy.*

Illustrating occult dangers from secondary disturbances in the neighbourhood of conductors.

"The author cites three cases of buildings set on fire though protected by lightning rods. But the precise cause of the fire was not ascertained."

Illustrating multiple flashes.

"In each of two cases the lightning struck at once the three rods fixed to a building."

Illustrating that a poor earth is not necessarily fatal to the efficiency of the conductor, except as to the protection of the soil itself and of things buried in it.

"Out of fifteen cases of lightning rods struck, in which the conductors were simply buried more or less in the soil, they carried off the strokes in eleven without the buildings being injured or any trace being left of it, except that the ground was upheaved where the latter was too dry."

Illustrating a matter important, if true: suggested by Prof. Fitzgerald theoretically at Bath: not yet verified by me.

"In two cases the stroke broke the conductor at points where its direction was abruptly changed."

Illustrating side-flash.

"In two other cases the lightning left the conductors struck, and fell upon buildings near, without causing damage to those on which the rods were fixed."

Illustrating brush discharge from conductor, and surging circuits its neighbourhood.

"Two electrical phenomena are to be noted as sometimes occurring when a lightning rod is struck. First, when a conductor is formed of metallic plates a peculiar noise is heard like water pouring on a fire. Second (independently of the form of the conductor), electric sparks are emitted from bodies near. The author cites examples at Berne, 1815."

44. The following illustrate the carrying power of fairly thin wire, and the fact that thin wires may protect although themselves deflagrated. *From Mr. Preece's Paper on "Lightning" to Society of Telegraph-Engineers, November*, 1872 (*L.R.C.*, p. 101):—"There were only two cases in the past season where line wires (No. 8 iron 0·17in. diam.) were absolutely fused.

From letter by Admiral Sullivan (*L.R.C.*, p. 195):—"You will like to know a case in which a copper wire acted as a perfect conductor, *though fused throughout its length*. It was at Monte Video, in the house of the English Consul; a flagstaff was struck and conducted the lightning through a flat roof near the bell wire of a suite of rooms (the wire ran in sight near the cornice) through a hole in each dividing wall, and then down to the bell in the basement. The wire was melted into drops like shot, which burnt a row of small holes in the carpet of each room. A dark mark on the cornice above showed where the wire had been. At the bell there was a slight explosion and some little damage, but I do not recollect whether anything acted partially as a conductor from that point and so carried off that part of the charge.

"This, I think, shows that even an ordinary bell wire will act as a conductor for a rather strong stroke of lightning, as the large flagstaff was shattered."

45. As illustrating that experience has led to the perception of the value of large surface to a rod, I may quote the standard American work, Spang's "Practical Treatise on Lightning Conductors." Philadelphia, 1887 (*L.R.C.*, p. 113):—

"A conductor of large surface exercises a much greater protective action than the same quality of metal in the form of a wire or solid rod.

"Not because electricity in motion resides on the surface, but that the expansive action of a discharge may have a wider scope through the metal."

[The incoherence of the reason does not destroy the correctness of the stated fact.]

Messrs. D. Munson and Co., of Indianapolis, Indiana, have sent me specimens of their rods, which have flanges and sharp edges, and in various ways aim at large surface. Their rods are composed of copper and iron mixed, which is curious, and their mode of attainment of large surface is needlessly complex.

The following illustrates the contradictory views about manner of conduction by lightning rods. *Letter from Admiral Sullivan* (*L.R.C.*, p. 199):—

"I firmly believe in the surface theory of Harris. I had been with him often when he made experiments nearly fifty years since, and witnessed a strip of tinfoil of the thinnest kind, and about ½ inch wide, protect a model mast of about six inches in diameter from electric shock, that without it split the mast to pieces, aided by a small hole through its centre filled with gunpower. And I

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always thought that the surface-conducting theory of Harris was indisputable. But about 20 years since, having to approve a proposal of the Trinity House for a new conductor of a lighthouse, which, like previous ones, was an inch in diameter copper rod called 'Faraday's Plan,' I thought I would go up to the Royal Institution and ask him why he did not use a copper tube instead, giving much greater conducting power with less copper. I did so, and he asserted positively that the conducting power depended entirely on the volume of copper in the section of the conductor, no matter whether it was in a bolt, plates, or tube ; and that if Harris said differently, 'he knows nothing whatever about it.' Of course I approved the rod-conductor ; but singularly enough, though I had not seen Harris for years, he came to town a few days after, and came to the Board of Trade to see me, and bring me a piece of his large tube conductor, with a connection that he was fitting to the Houses of Parliament. When I told him what Faraday's opinion was, he answered, 'Then he knows nothing about it.'"

(To be continued.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April* 27, 1889.*

The prevailing sensation in electrical circles continues to be the cutting down of the poles and wires by the Subway Board. Up to the present time of writing the city Bureau of Encumbrances, acting under the instructions of the Board, has removed about 100 to 125 poles and some 300,000ft. of wire, and would have removed more but for the fact that the companies have sent their men along the line in advance of the official gangs, and have themselves dismantled the poles. I need hardly say that this work has greatly interrupted electrical business of all kinds, and more particularly that of the electric light companies, although the main object of the crusade ostensibly has been to compel the Western Union Company to acknowledge the Board's authority. This week a fine line of poles on 42nd-street, 75-foot Norway pines, the property of the Metropolitan Company, were cleared away. Although the poles are not perhaps the most æsthetic objects we are wont to look upon, there are many among us who have a feeling of regret at seeing them disappear. The streets are undoubtedly a great deal more sightly than they were before the crusade began, but the question is now agitating electricians here as to the effect on all the electrical services. It is feared that they will be crippled in more than one way, for even if the subways proved equal to their work, the prices charged for operating in them are so high, it is claimed, as to place some of the services beyond the range of commercial possibility. In other words, it will not pay to operate under such conditions. Of course this remains to be proved, but I fear there is something in it. Another bad episode is the effect that is being had upon other communities. Thus, in Philadelphia the forcible removal of the telegraph and other poles and wires by the authorities has created a revived interest in the subject on the part of the city council, and we are likely to see similar work begun there, although Mr. Walker, the city electrician, says that only the Legislature can grant the necessary authority to abolish the overhead wires, and that it would take five years to provide the proper underground conduits. We must naturally expect, however, to see the underground work in such large cities as New York and Philadelphia, but the reform or improvement is reduced to an absurdity when it comes down to little places of ten or twelve thousand inhabitants, where the trim and well-kept poles are certainly not among the eyesores along the streets. For such communities to want underground wires is the height of folly, and it may be gravely doubted whether they do want them, although the local papers now and then say that such wires are demanded. It begins to look as though practical electricity would undergo a pretty severe ordeal in this country as the result of this work in New York, but we are fain to believe that it must lead us to better things of one kind or another.

The Westinghouse Electric Light Company report doing a very large amount of business with the alternating system. They state that during the first half of the present month they have received orders for alternating current outfits aggregating a capacity of 10,750 lights, which figures out a neat rate for the year if it were maintained. A year ago 79 central stations were using or erecting Westinghouse alternating plant, but at the present time the number has reached 160, with an aggregate capacity of 300,000 16 candle-power lamps. When it is remembered that the Thomson-Houston and Fort Wayne Jenney Companies are also in the field, busily engaged selling alternating current apparatus, it will be seen that the system has obtained good foothold in this country, and bids fair to maintain its position as an important factor in the electric lighting business. With regard to the Fort Wayne Company, it is to be noted that the Westinghouse Company has just brought an action against it for infringement of a patent granted to the United States Company, which it controls, on laminated cores for the armatures of dynamos. This patent was applied for in 1882 by Mr. Edward Weston, who was then connected with the United States Company, and was at last taken out a few days ago. It is quite a broad patent, covering "a core for electrical generators operating by inductive action composed of alternate sections, plates or discs of magnetic and insulating materials in combination with insulated coils wound thereon." Such a patent, if sustainable, is worth fighting for, and the suit just referred to is an indication that we are to have some more of the electrical litigation which has proved such a gold mine to the lawyers for years and years past.

The boom that I recently predicted in electric railways is now upon us, and construction work is now going on actively in every section of the country. Two electric railroads are being put in in Cincinnati, each of the overhead system, one using rail return, and the other complete overhead metallic circuit. At Topeka, Kan., the finest electrical railway in the West is now in operation, being 14 miles long, and having 20 miles of track. It will run 30 or 40 cars, and operates on the Thomson-Houston system. At Salt Lake City the Sprague Company have just received a contract for an overhead system, starting with 10 cars. They have also received another contract for a road to be put in at Portland, Oregon. These contracts involve the expenditure of very large sums of money, and the fact that so much is being invested in plant of this character shows how strong is the faith now felt by shrewd business men everywhere in the entire practicability of electric railways.

Mr. P. B. Delany whose synchronous multiplex system is said to be employed in your postal telegraph service, has brought out an improvement on the old Morse system which seems to add considerably to its value, especially in bad weather. Probably your readers, not being quite as familiar with the closed circuit Morse system employed in this country as with the open circuit and reverse current employed abroad principally, may find it strange to be told that frequently, with leaky lines, way or intermediate offices find it impossible to secure communication with terminal offices, and *vice versa*. This trouble is owing to the fact that the leaks on the line shunt sufficient current to cause the termiual operator's own relay to respond, and to make him think that all others on the line are receiving his signals, whereas those at way stations, not having their relays in adjustment, may be entirely unaware of any signals passing over the line. For this reason, therefore, being unconscious that the line is in use, say, between terminal stations (whose relays are always kept well adjusted), the way operators continually "break in," and thus make the line totally useless for communication. Of course this would not be the case if the reverse current were used with polarised relays, but as the Morse system is almost exclusively employed in this country, and frequently from 30 to 50 offices are placed on one line, especially in railroad work, some means of obviating this difficulty becomes of importance. Without going into the details of the methods employed by Mr. Delany, which, by the way, are very simple, I may state that the object is accomplished by causing two breaks to occur simultaneously at each end of the line whenever the key is depressed. It follows from this that no matter what the adjustment of any intermediate relay, with two absolute breaks in the line, however leaky the wire, the current is bound to be interrupted, and hence even badly adjusted intermediate relays will respond. The apparatus employed consists merely of an auxiliary trailer arrangement similar to that employed in Mr. Delany's recent system of cable transmission, which breaks the line at both ends for an instant at each contact of the key. I am told that the apparatus has been at work for some months on a number of railroads, and has given great satisfaction.

NEW YORK, *May* 4, 1889.

Electric railways have now been in operation in this country for some time in what may be called a practical shape, *i.e.*, in such a condition that their results should offer us some information or guidance as to their relative efficiency and economy. A great many estimates and statements have been made, but up to the present time we have had little in the shape of definite data. This lack now promises to be supplied very speedily, and there is every reason to believe that the publication of the figures will, if anything, increase the favour with which electrical locomotion is viewed rather than detract from it. Thus, for example, the president of the Sprague Electric Railway, which has been in operation for some months at Davenport, Indiana, comes forward with some very interesting comparative figures, and he naturally expresses himself as well pleased. This road, by the way, began with a good deal of confidence in electricity, for its

* This letter arrived too late for our last issue.—ED. *E.*

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horses were advertised for sale, if I am not mistaken, even before the electric motors had actually got down to their work. The company have been fully justified, however, on their own showing. The road now has four 14-foot cars in operation, each equipped with two 7½ horse-power motors, and it has also one 10-foot car for transfers. It appears that in December of 1887, with horses, the gross receipts were $1,283, and the net $353, whereas, with electricity, the gross receipts were $2,022, and the net $1,120. This shows an increase in the gross receipts of 59 per cent., and an increase in the net earnings of 220 per cent. I believe that these figures can be matched on various other roads, but, of course, as can be readily understood, a great deal depends both on the skill in management and on the cost of fuel. It has already been discovered that a careless superintendent can run his road into a ruinous condition in a very few months, while a careful one will have the cars in better condition a year after operation than when he began. What may be said of the superintendent may also be said of the drivers or "motorneers," as it is unfortunately becoming the fashion to call them. But it is remarkable how quickly the men, hitherto unaccustomed to handling machinery of any kind whatsoever, become familiar with the manipulation of the electric motors, a feature which augurs well for the general introduction of motors in every class of industry. Returning to the question of fuel, it may be pointed out that some of the roads have already utilised water-power with great success, but in other cases it has been found that coal was even cheaper than water. In other words, the power stations are simply burning up the heaps of culm, or coal dust, which have been accumulating for forty or fifty years, and which in some places, as at Scranton, are of prodigious extent. This culm can be had at a cost of something like 10 cents a ton, so that the station can afford to burn a good deal of it and yet not be worried as to the expenditure on its coal bill.

While I am speaking of electrical transportation, I may call attention to a new system which has been introduced recently by Mr. J. F. Williams, and is now being exploited by the Port Electric Company of this city. This system is based on the sucking action that a helix or coil exerts on a rod of iron placed near its centre, so that if the bar be placed with one end in the hollow of the helix, it will be drawn in on the passage of the current, and will be maintained in a central position as long as the current continues. If the current be broken the bar will again be free to move, and if we suppose the second helix to be placed in a line just beyond the first, then on the passage of the current through the second coil the bar will be drawn towards that and out of the first. Thus, with a number of helices arranged in a line side by side, with an arrangement for making and breaking the current at the proper time, the bar of iron can be moved continuously in any given direction. This is the idea upon which Mr. Williams has based his system, which he proposes to utilise for the transportation of small packages and letters. The experimental apparatus has been on exhibition in this city for some little time past, and has, I understand, created quite a favourable impression. In the model a road is shown which is intended to carry a small car for the transportation of medium-sized packages, &c. This car is in the shape of a long flat box, built of light steel, and rests upon a single rail, being guided by a small upper rail and two upper flange-wheels. The coils of wire are raised on a simple iron lattice-work, with a single support, and are covered in and protected from the weather. The track constitutes one side of the circuit, which passes through each helix by a contact point, and then to the other side of the main conductor. As soon as the circuit is closed through the helix the car is drawn in with a sucking action. This contact is maintained at each helix up to the time that the centre carriage runs to within a short distance from the centre of the helix, when the magnet which makes contact becomes neutralised and the contact is broken, throwing the current into the next helix; and this action goes on indefinitely, each helix coming into action successively. The current is thus utilised to the best advantage, and it will be readily understood that when once the carriage is in motion through the semi-tube, and its inertia has been overcome, comparatively little current will be necessary to maintain it at speed. As a consequence the strength of the current can be considerably diminished a short distance from the starting station, as the power required is decreased greatly when the carriage is run at its proper speed. It is also interesting to note that the current in the helix is considerably cut down by the counter E.M.F. generated by the passage of the carriage through them, so that, in a sense, the system is self-regulating to maintain the carriage at its proper speed. This system has been provided with a brake in the form of a helix, similar to the others, but provided with a contact that, unlike the others, remains closed after the carriage has passed the centre. The effect of this is that the car is retarded or pulled back, and it is remarkable how quickly this brake brings the car to a standstill.

There has been little business of any kind done in New York this past week, owing to the fact that Monday, Tuesday and Wednesday were given up wholly to the celebration of the centenary of the inauguration of Washington as the first President of the United States. The ceremony performed a hundred years ago took place in this city, then a little place of about 30,000 to 40,000 people, and it has now been celebrated with all possible enthusiasm, expenditure and *eclat*. One great feature was the industrial parade on the third day, in which at least 50,000 people actively participated. Although the electrical trades were not among those represented in the line, they were nevertheless brought forcibly to the public attention by means of the electric motors with which some of the machines on the huge trucks were driven. These motors were furnished with current from small sets of storage batteries, and were placed conspicuously so that millions of the spectators could readily see how easily and noiselessly they do their work. One of them was running a miniature chocolate factory, and another drove a neat little printing office. Another striking exhibit of the same class was that of a full-sized Thomson-Houston electric car built by John Stephenson, and intended to run on one of the roads in Brooklyn. It was a very handsome piece of work, and was probably the first electric car seen by many hundreds and thousands of the spectators.

You will remember that some time ago I made note of the intention to bring all the parent Edison companies into one big combination or corporation. For a time little has been heard about the matter, and in some quarters it has been rumoured that the programme would not be carried out. This, however, is wrong, and the certificate of the incorporation of the Edison General Electric Company has now been filed in this State; while $15,000, the State tax of ⅛ of one per cent. on the capital stock of $12,000,000, has been paid into the State Treasury It will be remembered that Mr. Henry Villard, once the controlling spirit of the Northen Pacific Railroad, is prominently connected with this stupendous scheme of reconstruction.

Dr. S. S. Wheeler, the electrical expert of the Subway Board, recently had an interesting summary in the New York *Electrical Review* with regard to cables recently put underground for arc lighting service. It goes without saying that such tests are for the present necessarily inconclusive, but so far as they have gone the results are better than might have been expected, and should they be maintained they will show that cable manufacture in this country for underground work has reached a high degree of perfection. Dr. Wheeler mentions that the cable laid last January in the suburb of Harlem over a short route has been in satisfactory operation ever since. With regard to an eight-conductor cable put in for the local Brush Company, and now in use, the fact is brought out that while the insulation of all the conductors is fairly good, two of them do not possess an insulation quite as high between wires as is required by the strict interpretation of the stringent rules of the Board. Probably there will not be a great amount of arc light cabling done for this reason, and the wires will be run individually. With regard to the insulation resistance of some of the cables, it is pointed out that the falling off now and again has been due to the exposure of the many ends of the cables to the atmosphere at the tops of the lamp-posts. Twice in damp weather the insulation was found to be very low, but by warming and drying the wires at the lamps it was very soon proved that the falling off of the whole cable was due to the exposure at these points, and a corollary was that the

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only part of an underground line that would not maintain a very high insulation during storms is the part that is thus exposed for the purpose of making the connections. Dr. Wheeler adds: "The tests made at the same time with the first-class overhead wires used to connect the underground wires showed that their insulation invariably fell in damp weather far below that of the cables, while, as stated before, when these terminals were properly dry the cables tested nearly as high in stormy as in dry weather."

BERLIN NOTES.

(FROM OUR CORRESPONDENT.)

BERLIN, *May* 5, 1889.

The Safety Appliance Exhibition, which was opened by the Emperor on the 30th ult., contains several electrical exhibits of interest. This Exhibition is the outcome of the Imperial message of November 17, 1887, and its aim is to bring before the public everything tending to minimise the dangers of moving machinery, manufacturing processes, &c., and to add to the health of the people. The electrical section is not confined to fire-alarms telegraphy and such like minor applications of electricity, but includes some heavy engineering exhibits. Among the electrical exhibitors are the Allgemeine Elektricitäts Gesellschaft, Siemens and Halske, the Deutsche Elektricitäts Werke of Aachen, and L. Schwartzkopf, who owns the Gülcher and the Zipernowsky-Déri-Blathy patents. Herr Schuckert, of Nürnberg, of course has some exhibits, but they are of a meagre character. I hope to give you a detailed description of some of the most interesting exhibits a little later.

The Physical Society of Frankfort-on-Main announce the completion of their electro-technical schools, the object of which is to give a theoretical training in electrotechnics to young mechanics who have served their apprenticeship in engineering or electrical workshops. As the fees are low, being only £5 a term, and the schools are well fitted up, the classes ought to fill.

Messrs. Hostmann and Co., of Hanover, are negotiating for permission to run an electric railway between Badenschenem, Baden-Baden, and Lichtenthal. There is considerable opposition to the scheme.

Herr Uppenborn, who has always maintained that all insulation tests should be made with E.M.F.s approximating those which are likely to be employed in practice, has recently published in the *Centralblatt für Elektrotechnik* some tables showing how very markedly the insulation resistance diminishes as the voltage increases. In the case of two cotton-covered copper wires twisted together the insulation resistance when using three cells of 1·7 volts each was 281×10^6 ohms, when using 10 cells it fell to 134×10^6 ohms, and when 16 cells were applied it fell to 121×10^6 ohms. On testing the insulation resistance of the slate base of a safety fuse Herr Uppenborn, when using 3, 8 and 16 cells, found it to be 68×10^6, 45×10^6, and 24×10^6 ohms respectively.

CORRESPONDENCE.

PROF. OSTWALD'S EXPERIMENTS IN ELECTROLYSIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has been pointed out to me by Dr. Armstrong, my co-secretary on the Electrolysis Committee, with reference to my letter criticising Prof. Ostwald in your issue of April 19 that the experiment I there criticised was only intended by Prof. Ostwald as a hypothetical one, or an experiment on paper. His statement rather is that if one imagined the experiment one could imagine such and such results, and could thence deduce conclusions having a bearing on certain points under discussion, and upholding the doctrine of extreme dissociation.

I thought at the time that most likely the experiment was only hypothetical, but did not like to assume it without clear evidence. In trying to avoid this assumption I may, perhaps, have fallen into the error of seeming to imply that Prof. Ostwald recorded it as an actual experiment with the wilful intention to mislead. If my letter bears this or any other offensive interpretation I beg to express regret.

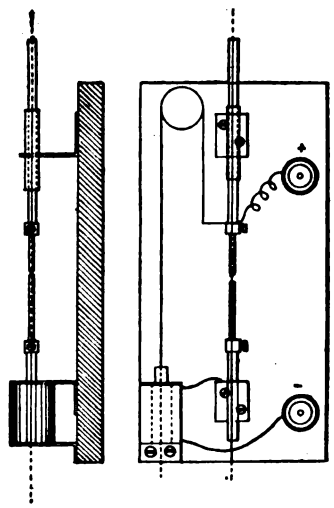
Foreign modes of expression and discussion are probably different from ours, and it may seem natural and useful to discuss hypothetical experiments and to deduce conclusions from them. My feeling runs rather counter to this mode of procedure, and that is all I would wish my previous letter to be taken as expressing.—Yours, &c.,

Liverpool, May 14, 1889. OLIVER J. LODGE.

SIMPLE ARC LAMP.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Seeing a sketch of above in your issue of May 3 makes me think the enclosed sketch may be of some interest. Having occasion some time back to give an exhibition of the electric light, and having no lamp at hand, I constructed the one shown out of various odds and ends lying about a workshop.



The solenoid was made from two pieces of brass $\frac{1}{16}$in. thick or so to form the end checks, one of which was bent out as shown to form the foot for attachment to wood base; these were soldered to a piece of $\frac{3}{8}$in. brass tube $2\frac{1}{8}$in. long, and dimensions of coil inside were 2in. long by 2in. diameter; this held $\frac{1}{2}$lb. No. 16 B.W.G. double C.C. wire easily, but 6oz. was plenty. The core was 3in. long by $\frac{5}{16}$in. diameter, and was a shade heavier than top carbon holder and carbon, and was adjusted so that when the carbons were in contact the core protruded about $1\frac{1}{2}$in.

Connection between top (+) carbon and terminal was by a spiral of copper strand; adjustment for current was by weights on top of (+) carbon holder. I found that to get a steady light the core had to be rather more than half-way through solenoid; and to check "hunting" I applied a light spring to introduce friction to the movement of upper rod.

Diameter of carbons, 4 millimetres "Hardtmuth," from Woodhouse, Rawson and Co. (judged from light given) about 6 or 7 amperes.

I may mention that the light was seen four miles off by a man who made out he was shooting wild ducks by the light given, and that in the town some quarter of a mile off it was thought by some that the house was on fire. The light being a novelty there, a crowd of some 200 persons were in the street in front inside of half an hour. The first trial was made with a solenoid consisting of only about one dozen turns of No. 18 braided wire (which we had handy), and stapled to the board.—Yours, &c., GEORGE T. PARDOE.

THE ELWELL-PARKER ALTERNATE CURRENT DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of May 10 we notice a letter from Messrs. Ganz and Co., in which they refer to a statement made by Prof. Forbes in his recent Paper on "Central Stations in Europe," that an alternating-current dynamo manufactured by us is a copy of one of their old-type machines.

We are sorry that the discussion on Prof. Forbes' Paper has not yet been published, as the facts given by Mr. Preece would have shown Messrs. Ganz that our latest machine is only slightly different in details from a machine patented and built by us in 1882, and prior to their patent. We enclose photo-

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graphs of the 1882 machine, which has a stationary armature, with flat coils laid on the inside and revolving field-magnets, similar to our machine of 1888, of which we also enclose photographs. Machines built in 1882 to the first patent ran very successfully, but at that time, there being no use for alternating-current machines excepting to run Jablochkoff candles, not much was done with them until the advent of the transformer.
—Yours, &c., (Signed) T. PARKER, Director,
For Elwell-Parker (Limited).

BOOKS, &c., RECEIVED.

"Practical, Plane and Solid Geometry." By John S. Rawle, F.S.A. (London: Simpkin, Marshall and Co.)

"Bericlet des Elektrotechnischen Vereines in Prag. 1888." (Prag: H. Merey.)

"Technology Quarterly." Vol. II., No. 3. (Boston: Massachusetts Institute Technology.)

"Joseph Henry and the Magnetic Telegraph." An address delivered at Princetown College, June 16th, 1885, by Edward N. Dickerson, LL.D. (New York: Charles Scribner's Sons.)

"List of Subscribers in the Scottish North-Eastern District of the National Telephone Company." (Dundee: R. S. Barrie.)

Journal of the Institution of Electrical Engineers. Vol. XVIII., No. 78. (London: E. and F. N. Spon.)

"Electro-Deposition." Third edition. Revised, corrected and enlarged. By ALEXANDER WATT. (London: Crosby, Lockwood and Son.)

"The National Telephone Company's English Districts Telephone Directory." 1889-90.

"Traité Théorique et Pratique d'Electrochimie." By Dr. Donato Tommasi. Vols. II. and III. (Paris: E. Bernard et Cie.)

"Un Voyage à Paris." By F. Julien. (London: Hachette et Cie.)

"An Exposure of Electrical Quackery," which appeared in the columns of the *Electrical Review*. Reproduced by the Committee for the Suppression of Electrical Quackery.

"La Meccanica delle Rotazioni." Traduzioni dal Francese di Ugo Bagnoli. By Giorgio Sire. (Sierra: Enrico Torrini.)

"History of the Transformer." By F. Uppenborn. Translated from the German. (London: E. and F. N. Spon.)

Illustrated Price List of Electric Bells and Accessories and Medical and Telephonic Apparatus. (The Electric Apparatus Company, Limited.)

PATENT RECORD.

APPLICATIONS FOR PATENTS.

3,487A. R. C. SAYER. Bristol. Improvements in means for actuating signals, switches and gates on electric and other railways. [This application having been originally included in No. 3,487, dated February 27, 1889, takes, under Patents Rule 23, that date.]

3,487B. R. C. SAYER. Bristol. Improvements in means for supplying electric current to road vehicles, boats and the like. [This application having been originally included in No. 3,487, dated February 27, 1889, takes, under Patents Rule 23, that date.]

April 18, 1889.

6,622. F. G. HOWARD, J. APPLETON, W. T. BURBEY and A. E. WILLIAMSON. London. Improvements in electrical switches, fuses, cut-outs, ceiling roses, lamp-holders, and the like.

6,628. W. H. SCOTT, and L. PARIS and SCOTT. Norwich Improvements in laying and insulating mains for conveying electricity.

6,654. J. BOLASCHOFF. London. Method of employing magnetism in connection with locks for boxes, doors and the like.

6,675. H. G. WATEL. London. Improvements in electrically driven fans.

April 20, 1889.

6,713. W. H. STURGE. Birmingham. Improvements in electric lamp fittings.

6,728. G. KAPP. Manchester. Improvements in the method of and means for the distribution of electric energy by alternating currents.

6,745. M. KILIANI. London. Improvements in the method of and means for electrolysis of substances in a state of fusion.

April 23, 1889.

6,804. W. R. LAKE. London. Improvements in telephone transmitters. (J. Straton, Canada.)

April 24, 1889.

6,847. G. E. DORMAN. Stafford. Improvements in meters for registering the passage of electric currents.

6,867. C. RICHARDSON and D. HILL. Manchester. Improvements in holders for incandescent electric lamps.

6,869. J. S. LEWIS. London. An improvement in the casings or covers of electric switches, cut-outs, and wall and ceiling fittings.

6,875. J. C. WILLIAMSON. London. An improved construction and mounting of the spring armature and hammer for electric bells and other like electrical instruments.

April 25, 1889.

6,883. L. B. ATKINSON. Clapham. Improvements in self-exciting alternate current dynamos, and self-starting synchronising motors.

6,884. L. B. ATKINSON. Clapham. Improvements in the means of obtaining motive power from alternating currents of electricity.

6,885. L. B. ATKINSON. Clapham. Improvements in apparatus for use with variable currents, and in the means of obtaining motive power from alternating currents of electricity.

6,942. J. LACHARIAS and F. MARX. London. Improvements in electrical accumulators or storage batteries.

April 26, 1889.

6,954. G. E. DORMAN. Stafford. Improvements in meters for registering the passage of electric currents.

6,974. G. E. DORMAN. Stafford. Improvements in regulators for controlling the production and utilisation of electric currents.

6,981. J. KEMSLEY. London. Improvements in annunciators in connection with electric, pneumatic, or other bells.

7,002. T. H. HICKS. London. Improvements in electric secondary or or storage batteries.

COMPANIES' MEETINGS & REPORTS.

Western and Brazilian Telegraph Company (Limited).

The seventeenth ordinary general meeting of this Company was held at Winchester House yesterday (Thursday), Mr. W. S. Andrews, chairman.

The SECRETARY read the notice convening the meeting. The minutes of the last general meeting having been read,

The following report of the Directors was taken as read;—

"The total earnings amount to £112,250. 6s. 11d., as against £78,369. 18s., showing an increase of £33,880. 8s. 11d. compared with the half-year to 31st December, 1887. The working expenses amount to £31,220. 4s. 2d., as against £30,903. 1s. 6d., an increase of £317. 2s. 8d.

Including the amount brought forward from 30th June, 1888 (£3,293. 16s. 8d.), and the dividend received upon the shares held in the "Platino" Company, the balance to the credit of the revenue account is £98,592. 4s. 5d., from which has to be deducted £13,500 for debenture interest, and £929. 5s. 2d. for expenses and stamps in connection with the transfer of the Platino Company's shares, leaving £84,162. 19s. 3d., of which £7,000 has been placed to the renewal fund and £6,400 to the Debenture Redemption Fund. This leaves £70,762. 19s. 3d. The Directors now recommend the payment of a final dividend of 9s. per share, free of income tax, on the Ordinary shares for the half-year, making, with the dividend paid in November, £5 per cent. for the year. The dividend for the year 1887 was at the rate of £4¼ per cent. per annum.

In the case of shares which have been divided into Preferred and Deferred, 1s. 6d. per share of the dividend now recommended will be payable to the Preferred shareholders, and 7s. 6d. per share to the Deferred shareholders.

The balance remaining is £29,561. 17s. 3d.

The shareholders are aware that there has been, and continues to be until 1910, an annual charge upon revenue of £1,200 to repay to the capital account the discount of £36,000 given upon the original issue of debentures; of this discount £9,900 has been paid off, and a balance of £26,100 remains. The directors propose to apply £26,100 of the balance of £29,561. 17s. 3d. to secure the following advantages:—

1. The paying off the above item of £26,100.
2. The getting rid the annual charge upon revenue of £1,200.
3. The allocation of the £9,900 already paid, and of the £26,100 now to be paid, to the credit of capital.
4. The reduction by these amounts of the necessary capital to be provided for the new cables.
5. The diminution of the annual charge to be incurred on this account.

It is clear that any reorganisation of the Debenture capital referred to in paragraph 14 would be rendered more difficult by a standing debit item in the accounts referable to its issue. There will remain a balance to be carried forward of £3,461. 17s. 3d.

The payment received for the directors' fees in the Platino Company for nine months, £900, has been placed to the credit of the capital account, so that the sum originally paid as compensation will be gradually returned. Of the total amount that may be required to provide for the making and laying of the loop cables, £36,000 is provided by the repayment made to capital account. The Company has power to issue £50,000 of debentures ranking with the present "B" debentures, and the balance which may be needed will be taken from the renewal fund. The loop cables when laid will largely tend to ensure uninterrupted communication over the Company's line, and this additional security will entail only a very moderate charge upon revenue.

The debentures will be offered to the proprietors when required to be issued. The annual drawing of the existing "A" and "B" Debentures at

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par will commence in February next year, when £11,200 will be drawn, and from that date the debentures will be redeemed by progressively increasing drawings. The directors referred the question of replacing the existing debenture debt of the Company by permanent debentures at a lower rate of interest to the Company's solicitors and counsel, who have advised that any measure affecting the status of the existing debentures will require the individual assent of all the holders.

Since the last half-year's report 1,310 "Platino" shares have been transferred by shareholders in exchange for 786 shares of this Company."

The CHAIRMAN then said it had been his pleasing duty on the last few occasions that the shareholders had met to congratulate them upon the continuous increase of traffic with which the concern had been favoured. He was pleased to say that to-day formed no exception. The traffic for the last half of 1888 was the largest traffic that they ever had in one half-year since the undertaking had been formed. The corresponding half-year was a very satisfactory one, but the last showed, as compared with it, a receipt of £112,250, the previous receipt having been £78,369, and the increase, December, 1888, compared with December, 1887, was therefore £33,880; that, of course, was eminently satisfactory. It appeared to him that it would be equally satisfactory to them to learn that the large increase of nearly £30,000 had been earned at an increased expenditure of £317. 2s. 5d. He did not think that many companies could call in so large a receipt as that with so small an increase of expenditure. This increase, they find, had arisen at the stations abroad, in the salaries and wages, and an increase which was attributable to a largely increased payment on account of the high rate of exchange which they had heard of previously; to certain increase of staff, and to a bonus which the Directors had to give to the staff on account of the expenses of living, additional work, &c.; and considering that these men had done all the actual work of earning an increase of £33,000, he did not think the shareholders would object to it. The other items were very small. Taking Abstract B, the cost of ships, they had an increase of £837, nearly all for additional stores supplied to the "Norseman," and a decrease of £1,020 arising through a lessened expenditure on account of coal. They were fortunate enough to effect charters for both steamers, from which a sum of £1,323 had been derived; so that, deducting that and the other savings from expenditure, they had considerably reduced the expenditure in the two ships. Under Abstract C, expenses at home, which, though shareholders—and very properly so—generally looked at with a considerable amount of attention, there was an increase of £226, less a decrease of £33, being a net increase of £193, which covered all the additional labour consequent on increased business. This they might regard as being satisfactory. On the 1st of April considerable reductions were effected in the rates between this country and Brazil, in order in the one direction to develop the communication by telegraph between this and the neighbouring countries, and in order also—and that was a very important element in the consideration of the question—to satisfy customers. Customers appeared to have what was termed by Mr. Disraeli an ignorant impatience of taxation; they always cry out "high tariff," because whatever it is, customers always call it high. They always want a lower one if they can get it. They had hoped by the time this meeting was held that they would be able to tell them something as to the effect of the reduction in the tariff, but most unfortunately the line between Pernambuco and Rio broke down on March 31. As if that was not sufficient, the line broke down between Rio and Santos on April 15, and on the very day of the repair of the first break, between Pernambuco and Rio, the line between Grandu and Chili broke down, on April 25. These breaks, of course, have taken up a great deal of time. All the lines were repaired on May 15. Of course that being so recent, it is impossible to calculate what share of the loss of receipts had been occasioned by interruption, and what share of the lessened receipts was due to the reduced tariff they have no means to arrive at; but one thing they had arrived at in their own minds, namely, that these accidents proved the necessity and the wisdom of the policy which the shareholders determined to carry out, of laying these loops. If these loops had been down instead of being projected they would probably—he did not say certainly—have been in the enjoyment of the full amount of revenue. There was no doubt that certainty of communication with these loop cables tended to keep and develop a large trade, and it is an encouragement in the direction of an increase of business consequent upon the reduction, because the business would be reliably done. They could not tell the impulse that this would give to the trade yet; probably they would shortly With regard to the loops, a shareholder had approved of other precautionary methods in the shape of preserving the reserve fund; the Directors had to look about them, and, with the policy of the shareholders in their minds, to see in what way they could effect the laying of the loops. One thing which had struck them was that they had 50,000 of "B" Debentures unissued which would rank with the existing "B" as regards the charge they held on the Company's effects, and which, therefore, would stand pretty well as to terms per issue. They must not suppose that the Directors were thinking of issuing these Debentures at 6 per cent. interest; they had no idea of doing that or anything of the sort. Turning their attention, however, to Preference shares, the same objections applied; they could not either issue Ordinary shares at discount as it was illegal. The Directors were driven back, as it were, upon what they could put their hands for the benefit of the shareholders. Having reached that, matters were very much simplified. There were only two methods of dealing with the thing as far as they could see—the one was the issue of £50,000 of Debentures, and take the whole that might be required from the reserve fund; and when they came to consider they found it was impracticable, because it would deplete the reserve fund to such a large extent as to very much weaken the soundness of their financial position; and consequently, after careful and exhaustive examination, they arrived at the result communicated in the report to the proprietary body. There was on the one side of the account a very unsatisfactory item of discount on the old issue of Debentures, which was not a pleasing item. It was not an item which would assist the Board in the reorganisation of Debentures; in fact, it was necessary that it should be got rid of, because if they got rid of it they got rid for a great many years of an annual charge of £1,200, which became realised for the general purposes of the Company. This was, therefore, looked at with a favourable eye, together with a further sum of £900 paid to the Western Brazilian Company by the Platino Company in liquidation; and looking at the terms at which the Debentures could be issued, the Directors thought they saw their way without touching the reserve fund at all. As regarded the issue of Debentures and payment for the cables, of course that would not all be required at once—perhaps not for a year. The first operation they would bring into effect was the use of the cash they had; the second would be the sale of a certain number of securities as might be required for the renewal fund; and the balance would be the issue of Debentures, which would take place last of all. These Debentures would be offered to the proprietors, and he hoped a good many would come forward and take them. They had not been able to go further with respect to the loops than to consider the best way in which they might be laid. They could not do anything positive until the shareholders approved of the plans. It was probable expeditions would have to be sent out, but that had not been fixed. When they knew the policy of the shareholders they would immediately set to work to put the thing into one shape or another. There was a subject he was bound to touch upon. They had been informed that a circular had been issued to a number of shareholders inviting them not to give their proxies to the Board, but to certain gentlemen who were named. There was no reason to complain of that, but it was a somewhat extraordinary position for gentlemen to take up before they knew what the policy of the Board was. These gentlemen also did not inform us what their opinions were, nor upon what ground they desired the proxies in their favour. They might have come to them and stated their views, and we could have seen if we could meet them. He would conclude by moving the adoption of the report and the payment of a dividend of 5 per cent.

Questions were then asked by Messrs. GUESDEN and GROVER, which were answered at some length by the Chairman.

A resolution was then put by Mr. COPPIN, seconded by Mr. WEDGWOOD, in opposition to the report, which was negatived.

The report was then adopted by a large majority.

The retiring Directors were re-elected.

Mr. Griffiths was appointed second auditor along with Mr. Weise.

A vote of thanks to the Chairman then brought the proceedings to a close.

The West Coast of America Telegraph Company (Limited).

The twelfth ordinary general meeting of this Company has held on Wednesday last, at Winchester House, Old Broad-street, Mr. Alfred Marshall presiding.

The SECRETARY (Mr. Fred. L. Robinson) read the notice convening the meeting, and the minutes of the last general meeting. The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: Gentlemen, you have all had a concise and complete statement of the business of the past year, so that I have very few remarks to add to what is presented to you in the report. The chief feature of the accounts is the large increase of £7,820 in the gross earnings of the Company during the past year. Doubtless you will agree with me that this is a satisfactory increase. I now come to the other side of revenue account, and it is an equally pleasant feature that this great increase has been accomplished with an increase of only £289 in the expenditure account. Going more into the details of the expenditure account, you can see that the West Coast expenses, which include salaries and stationery, and so on, have increased in proportion to the work done. On the other hand, we have been fortunate in having very few interruptions in our working during the past year, so that the smaller expenses of our repairing steamer, and the smaller expenses in the maintenance of the cables, about compensate for the increase of working expenses. I can only express a hope that during the current year we may be as free from those unpleasant interruptions which cables are naturally liable to as we were during the last twelve months. We shall keep our steamer ready at a moment's notice to repair any damage that may occur. We have been generally successful in keeping down interruptions to within a few days. You will see that we are able to place a very handsome amount to our reserve this year. At the same time I wish it were even larger, and I hope during the present year, if we go on as steadily as we have done hitherto, that we shall be able to recommend that even a larger sum should be placed to reserve. There has been a very good trade on the coast, and a great many companies have been formed during the past year, and I think that has materially assisted to bring up our earnings to the satisfactory figure we can show. We can hardly expect that as many companies will be formed during this year as there have been lately; but the tendency of telegraphy is to increase, particularly if, as we hope to be able to do, we reduce our rates a little in proportion to the increase in our earnings. You will see that amongst our assets in the balance-sheet there appears an item of £4,000, which was the cost of the land line between Valparaiso and Santiago. We thought it of great importance to get into direct communication with the capital, and for that purpose we acquired a concession to lay a land line between Valparaiso and Santiago; but after we got the concession the people working the existing line, which had been in operation for several years, approached us and offered to sell their line to us, the terms which they gave

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to us being according to our ideas satisfactory. We thought it better to acquire the existing line and to be able to commence working at once, and at the same time avoid competition. I am glad to be able to say that our expectations have been realised by good work on that new line. We have increased the earnings, and we are getting a satisfactory return for the capital laid out. Besides this increase to our line, we have made arrangements for direct communication between Iquique and Pisagua, which is one of the nitrate ports. At one time there were as many as eighty ships in it, which shows the great importance of the port, and every ship means more or less traffic for us in communicating with the captains, and so on. You will all, no doubt, sympathise with us in the loss of our late colleague, Mr. Campbell. He was a conscientious, hard-working man at the board, and we are very sorry to be deprived of his services by death. He concluded by formally moving the adoption of the report and accounts.

Mr. FREDERICK WALTERS seconded the motion.

Mr. L. WELLS said he rose with great pleasure to congratulate the Directors on the satisfactory state of the accounts. He wished, however, to make one or two remarks on them. Since he had become a shareholder in the Company twelve months ago he had taken a great interest in its welfare, and had watched the published returns of the traffic which had appeared monthly. He had taken out the figures for 1888 each month separately, and the total aggregated £59,775, but in the statement before them it appeared to have been £64,583, or a very satisfactory addition of £4,808. Perhaps the Chairman might explain the cause of the difference. It was a very satisfactory increase, and was no doubt capable of explanation. The other topic to which he would call attention was the reserve. On one side of the balance-sheet it appeared as £27,000, to which according to the report they had added £12,000, raising the total of the fund to £39,000. On the other side of the balance-sheet he observed that the investment account figured at £33,203, showing that the Directors had invested any surplus money which they had in hand. But in that account—and he mentioned the subject at the last meeting—he thought it would be better if the Directors gave the particulars of their investments. All the other telegraph companies without exception gave those particulars, and there could be no motive for keeping back the information, because the shareholders had every confidence in the Directors, and were quite sure that the fund was very well invested. It would really tend to give confidence to the shareholders generally if they could see that their money was invested in such securities that were easily convertible, and prove that the reserve fund was really and actually what it professed to be.

Mr. GARDNER said that he was greatly in favour of adding to the reserve fund. He would have preferred to receive 5 per cent. dividend this year than 6 per cent. if they had, instead of giving 6 per cent., added 1 per cent. more to the reserve fund. He wanted to see the hands of the Directors strengthened, in view of the heavy responsibilities they had to meet in paying off their debenture liabilities.

Mr. WELLS quite agreed with the previous speaker, that the reserve fund should be increased, but not necessarily at the expense of the dividend of the shareholders. The receipts for the first four months of this year showed a very large increase over the corresponding months of 1888, and this increase might fairly be divided between the shareholders and the reserve fund.

The CHAIRMAN: We are very anxious to have a large reserve fund. At the same time we are also desirous of satisfying the legitimate aspirations of every shareholder to receive a fair dividend for his investment. Mr. Wells has asked me to explain the apparent discrepancy between the earnings which are published in the newspapers and the gross earnings which we give in our report. The gross earnings in our report contain not only the traffic receipts but also the earnings of our repairing steamer. We have an arrangement with a neighbouring Company by which they pay us what I may call a retaining fee—a very large round sum—which helps materially to keep down our expenses. We keep our steamer at Callao, which is the connecting point between our own line and that of the Central Company further north; and our arrangement is this, that the Company whose cables are first interrupted has the first use of the steamer. They pay us £6,000 for this consideration, not having a steamer of their own. I think you will say this is satisfactory. As regards the reserve fund, the investment account is mentioned in our balance-sheet at the amount at which it stood on December 31. It does not include any investments made this year out of present earnings, but part of our reserve may be said to consist in stocks of the cable.

Mr. WELLS: That appears in the balance-sheet.

The CHAIRMAN: Yes. As to our giving details of our investments from the commencement, we have adopted the plan of not publishing them, and we always consult our auditor and are guided by his recommendations in making investments. We never make any without his approval.

Mr. WELLS: Every other company gives the details of the investment account.

The CHAIRMAN: We held our own debentures formerly, but the auditor did not think it the right thing to do. We have consequently during the last year realised them at a good profit beyond what they cost, and invested in more convertible securities.

He then put the resolution in the usual way, and it was carried unanimously.

The CHAIRMAN next moved—

"That a final dividend at the rate of 1 per cent., free of income-tax, making 6 per cent. for the year, be declared, payable on the 16th inst."

Mr. HENRY ROBERTS seconded the motion, which was carried unanimously.

On the motion of Mr. ROBERTS, seconded by Mr. C. E. MASON, the retiring directors, Mr. Alfred Marshall and Mr. Frederick Walters, were unanimously re-elected to their seats at the board.

Both these gentlemen having briefly acknowledged their re-appointment

Mr. WELLS proposed, and Mr. LAMONT seconded, the re-appointment of Mr. J. Weise as auditor of the Company. The motion was carried *nem. con.*, and a vote of thanks having been passed to the Chairman, the proceedings terminated.

The Maxim-Weston Electric Company (Limited).

The statutory first ordinary general meeting of this Company was held yesterday at Winchester House, Old Broad-street, Mr. John Marks presiding.

The SECRETARY (Mr. Samuel J. Boyce) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, as you will have gathered from the notice just read, this is merely the statutory meeting, and, therefore, a meeting of a purely formal character, called in compliance with the Act of Parliament, which says that within four months of the registration of any new company the statutory meeting shall be held. There is, therefore, really no business for us to transact to-day, and there is no resolution for the Directors to put before the shareholders; but now that we are here I may take the opportunity of making a few remarks, and in the first place I have to inform you that we have unfortunately lost the services of two of our Directors—Mr. Harvest, who we regret to say has been taken from us by death, and Mr. Hildyard, whose business requires the whole of his time and attention, thus necessitating his resigning his seat at the board. On the last occasion we met it was for the confirmation of special resolutions for the reconstruction of the Maxim-Weston Company, I think. I may mention that since then we have had applied for, and have allotted, out of the 312,000 shares, 262,000, so that the whole of the number that we were able to allot in the new company have been allotted with the exception of 50,000. Now that I am on this point I may mention that the liquidators have requested the Directors to offer to the shareholders these 50,000 shares if they are disposed to take them up. I may mention that at the time applications were made for the new shares a very large number of shareholders indeed applied for more than they were legally entitled to under their holding in the old company. Now if those shareholders, and, indeed, any other shareholders, are desirous of tendering for any portion of those 50,000 shares with the understanding that in addition to the price at which they tender there is a liability of 1s. beyond that, because they are 3s. shares, with 2s. credited as paid up, we shall be happy to consider their applications. We are not particularly anxious that the shareholders should take them up, because we could place every one of these shares within twenty-four hours of the present time; but we think that the shareholders should have the option of taking them if they think fit. We therefore invite them to tender for the same, with the understanding that the tenders must be lodged within seven days of the issue of the circular we are now preparing to send to the shareholders. The dissentient shareholders in the old company represented 24,000 or 25,000 shares, but I am happy to say that we have been able to arrange terms of settlement with the whole of those dissentients, on what we consider fair and equitable grounds. We shall therefore, I am pleased to say, have no litigation whatever with the dissentient shareholders. Since our last meeting we have been fortunate in securing the services as general manager of Mr. Hamilton, who may not be known to gentlemen outside the electrical world, but who is very well known to those who are connected with electric lighting; and I am sure he will be a very valuable acquisition to the Company, and we hope with his aid to be able to do such a business as will enable us at the end of the financial year to come before the shareholders and give a good account of our stewardship. I may tell you that we have concluded some contracts, and others are now in negotiation. One contract of an important nature is for the laying down of 1,000 lights. I do not propose mentioning publicly where that installation is, but if any shareholder is desirous of knowing that, we shall be pleased to give him the information if he will apply privately for it at the office of the Company. We do not think it is advisable to state publicly where we are carrying on work; but this is an installation which, although an important one in itself, is likely to lead to far greater results in the same direction, and from which we hope to realise profitable returns. If there is any information that the shareholders wish now, we shall be happy to give it. We can only say that we consider we are going on in a very satisfactory manner, and we hope, as I have said before, that at the end of the financial year we shall all come before the shareholders and give them such an account of our stewardship as will be satisfactory to them and to the Directors.

A SHAREHOLDER asked when the next call of 6d. per share would be made.

The CHAIRMAN said it was due six months from the date of the reconstruction of the Company, or two months from the present time. He had no doubt that the call would have to be made at the proper time.

A SHAREHOLDER asked what stage the pending legislation between Mr. Watt and the Company had reached.

The CHAIRMAN said that they hoped that their action against Mr. Watt would soon be down for hearing. The Company's claims against Mr. Watt amounted to about £4,000, while that gentleman's claims against the Company amounted to £1,700.

The proceedings then terminated.

Newcastle and District Electric Lighting Company (Limited).

The first general meeting of this Company was held on the 13th inst. at Newcastle, "to receive the report of the Directors as to the progress of the Company, and to transact the other ordinary business of the Company." On

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the motion of Sir B. C. Browne, seconded by the Hon. C. Parsons, the chair was taken by Mr. J. D. Milburn.

The CHAIRMAN said this was a meeting which they were obliged to hold under the Act, which enjoined that a general meeting of the Company should be held within four months of its registration; and it was customary on such occasions to give the shareholders a report of the progress of the work. It was necessary to consult the local authority and get them to acquiesce in the establishment of the Company; and in regard to this the Company had had very little trouble with the authority. They had then to make application to the Board of Trade for a license; and two months' notice of this had to be given in order that anybody objecting to the establishment of the Company might have the opportunity of doing so. The notice would expire on the 26th inst.; and, so far as the Directors knew, there was absolutely no opposition. The Directors hoped by the end of May or the beginning of June the sanction and license of the Board of Trade to commence work would be obtained. In the meantime the Directors had made several important contracts. The dynamos and engines had been partly contracted for, and he believed they could be ready almost immediately. All the boilers required for the first section of the work of the Company had been contracted for, and would be delivered at the end of June or early in July. The Directors, after consideration, had chosen at the Forth Banks a site for their central station; and as soon as the Board of Trade license was received would erect the seatings for the boilers and also chimney; and the Company would begin to lay cables in order to supply the current to customers. The system of lighting adopted by the Company was that of the moderate tension of 1,000 volts; and it was thought that with this system—which was pretty familiar to most electric lighting companies—the Company would be able to efficiently light the area round about. The Company not only pretended to light Newcastle, but had power to light the district; and they might have to adopt a higher tension, something like 2,400 volts alternating current, or even more; and under these circumstances the Directors thought it wise to lay such cables and such transformers as would carry the heavier voltage. The machines adopted were those of the turbine system now so well known in this district, such as had been supplied to a great number of steamships and works, and were giving very great satisfaction. These turbine engines had been ordered from Messrs. Clarke, Chapman and Parsons, and were being constructed with the very greatest care; and he had no doubt they would give every satisfaction to the Company. The boilers, three in number, of the high pressure of 140lb. to the square inch, were being made by Messrs. R. and W. Hawthorn, Leslie and Co., at their works adjoining this Company's station at the Forth Banks. It had been a particular order of the Directors to have more boiler power than was even necessary for the first section. So much for the work which had been going on in the way of erections; and he would now say a few words in regard to the business operations of the Company. The business staff of the Company had not been idle; they had been canvassing all along, and more particularly of late, and at the present time there were signed applications for lighting amounting to 35,000 candle-power incandescent lights, or 3,500 lamps of 10 candle-power each, which was about half the amount required to keep the first section fully going. The Company were daily increasing their connections. Tradesmen and others likely to make use of the light, seeing that the Company were going about the matter in a business-like way, were giving every attention to the members of the staff who called upon them; and there was no doubt that in a very short time there would be more business than the first section of the work would be able to undertake. The Directors were determined upon two or three things. The first was that they were resolved to give a good steady light; and, the second was that they were going to ask a fair but sufficient price for it Several electric lighting companies had come to utter failure, and ended in disaster; and there were, he thought, three reasons for this: the first reason was the heavy initial expenses; second, a bad selection of machinery, cables, &c.; and third, asking a price totally inadequate for the work they were going to undertake. There must be a great many unknown elements in such a new thing as electric lighting; and some of those companies had the absurd and Quixotic idea that it was their duty to enter into a death struggle with gas right away. The Directors of this Company did not hold such an opinion. Gas has been a useful servant in the past, and when it had become a thing of the past, so far as an illuminant, it would continue to be a good servant for many other purposes. The Directors did not intend to go to war with gas, but they intended to give a light of a higher order than gas, and would charge a price somewhat higher—nominally higher, because it would be a matter of calculation whether that price would be really higher or not. By using the electric light there would be a great saving in the damage done, especially in large warehouses where delicate fabrics were stored; and it would also prevent damage in picture galleries. It would be a much healthier light for theatres, concert rooms, and ball rooms, for the electric light, by its incandescence, absence of heat, and more especially the utter absence of any noxious fumes, allowed the air to be entirely unvitiated, and rooms to be properly ventilated. The price which the Company intended to charge was 5s. for 10,000 watt-hours, which was 6d. per Board of Trade unit, with varying discounts according to the quantity of light taken. There were twenty-nine or thirty customers' names in the Company's books who had already begun to have wires placed in their premises, and who were quite content with the price. The capital of the Company was nominally £50,000 in 5,000 shares of £10, but it was proposed to issue only 2,000 shares at present. There had been 1,200 to 1,400 shares allotted, which were subject to £7. 10s. being called up. More than this number were applied for some time ago, but, upon the suggestion of Mr. Parsons, the managing director, applications were in some cases cut down, and the assurance was given to applicants that an opportunity to take more shares would be given them after the prospects of the Company had been more clearly ascertained. Now that the future prospects of the Company seemed to be fully assured, and no opposition being offered to the granting of the license of the Board of Trade, and the Directors having every confidence in the successful working of the Company, it was proposed to open the list to the end of the week to close up the amount required for the first section; not that it would all be required, but the more shares subscribed the smaller would be the amount to be called up. The Directors did not fear anything about capital; they thought the difficulty hereafter would be to refuse capital. They did not intend to go on too rapidly; they intended to win station by station, and at each succeeding station they would take advantage of all known improvements. The Directors were determined to do their very best to make the Company a great and established success, without entering into any Quixotic competition with anybody.

This concluded the ordinary meeting, after which an extraordinary general meeting was held to consider and approve the proposed Articles of Association of the Company.

Mr. W. S. FINDLAY moved that the Articles of Association be adopted.

Sir B. C. BROWNE seconded the motion. He said the company had been exceedingly fortunate in having obtained the services on the Board of Directors of Mr. A. Wade, who was connected with the London Electric Supply Corporation, which had hitherto been treated at the Grosvenor Gallery, but had now started enormous premises at Deptford, which would be by far the largest and most important electric premises in the world. Mr. Wade was associated with those works; and having Mr. Wade as a Director this Company was connected with the very front rank of the electric lighting movement, and this he hoped might be considered another guarantee for their success. Lord Crawford, another Director of the London Electric Supply Corporation, was also one of the original shareholders in this company.

Mr. W. M. ANGUS and Mr. A. WADE each spoke in support of the motion, and it was agreed to unanimously.

On the motion of the Hon. C. PARSONS, seconded by Mr. FINDLAY, a vote of thanks was passed to the Chairman, and the meeting concluded.

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Woodhouse and Rawson (Limited).

The following is the report of the Directors to be presented at an extraordinary meeting of this Company, to be held at the Cannon-street Hotel, on Friday (this day), at three o'clock. The meeting will be further asked to sanction the declaration of a dividend and to consider and, if thought fit, to pass the following resolution :—

"*The agreement,* a draft of which has been produced to this meeting and initialled by the Secretary, is hereby approved, and the Directors are hereby authorised to enter into the same and to carry the same into effect.*"

The accounts show a profit for the second six months amounting to £9,771. 13s. 3d., making a total profit of £21,440. 2s. 11d. for the year. Of this amount the Directors propose to transfer £12,000 to a reserve account, and from the balance, £9,440. 12s. 11d., to recommend a dividend at the rate of 12 per cent. per annum for the half-year ended June 30th last on the amounts paid up at that date, which, with the interim dividend already paid, will make 12 per cent. for the year ; this will absorb, say, £8,000, leaving £1,440. 2s. 11d. to be carried forward.

With regard to the working of the Company, the installation department maintains its character for high-class work, and it is found that a good class of wo k is obtained, and that through the best advertisement—that of the recommendation of clients.

The foreign business has assumed such large proportions as to justify the expectation of profits far in excess of anything previously anticipated. Contracts have been recently signed whereby the company will not only obtain a very large sale for its various manufactures and commodities in one of the principal countries of Europe, but also secure a large immediate profit. At present there are negotiations abroad for a contract for the supply of double the present output of incandescent lamps for five years, and there is every reason to hope that the negotiations will be successful.

Of the subsidiary companies in which this company holds a large interest, the Woodhouse and Rawson Supply Company of Great Britain (Limited) has done especially well, and there has been a great increase in its general business. This company supplies every class of electrical requirements, as is shown by its price lists, which are the most complete of the kind.

Returns furnished by the Woodhouse and Rawson Electric Contract and Maintenance Company, Limited (Lancashire, Yorkshire, and Cheshire), show a steady and gratifying improvement, and the supply of current from the electric light station put up by the Bradford Corporation, which is expected to be shortly available, will lead to a large increase of the business.

The Woodhouse and Rawson Electric Manufacturing Company (Limited) has large orders in hand for electrical work, and has obtained the sole manufacture of several important specialities during the past year.

At the extraordinary general meeting of shareholders, held on the 14th of December, 1888, the chairman gave a detailed account of the progress of the Company's business during the year 1888, and explained that the further development of it made it desirable to increase its working power by the formation of a large company, formed to take over this and other undertakings. He also explained that the amalgamation of this Company with its subsidiary companies would be very desirable for several reasons ; amongst others, it was practically the only way to put an end to the Founders' Shares, which are now entitled to so large a share of all the profits beyond 10 per cent.

The arrangements are now nearly complete for the formation on very satisfactory lines of the new company already referred to, which will take over the business of this and other Companies, and it is expected that it will be brought out in a very short time. The shareholders in Woodhouse and Rawson (Limited) will under the proposed scheme receive fully-paid shares of the new company to the amount now paid up upon their shares, and in addition thereto a bonus of 10 per cent. thereon, half the amount to be issued to them being in Preference shares and half in Ordinary shares. It is also intended, in addition to paying the dividend mentioned above, to distribute certain assets reserved to this Company by its agreement with the new company.

The agreement, together with details of the new company, will be explained to the shareholders at the ensuing meeting.

* The agreement referred to is with a view to carry out with some modifications the scheme for the sale of the property and undertaking of the company to a new company, which met with the general approval of the shareholders at the meeting on December 14, 1888. The terms of the agreement are to be explained to the meeting.

NEW COMPANIES REGISTERED.

CROMPTON-HOWELL ELECTRICAL STORAGE COMPANY (LIMITED).—This company was registered on the 3rd inst. with a capital of £19,600, in six founders' shares of £100 and 19,000 ordinary shares of £1 each, to carry on the manufacture and sale of secondary batteries, and to take over the business of the Crompton-Howell Electrical Storage Company. The first subscribers are :—J. Albright, Mansion House-buildings, E.C. ; J. C. Howell, Caeffain, Llanelly ; H. Laurence, 29, Grove Hill-road, S.E. ; G. Hartmans, 28, Hartington-road, Ealing ; H. Dowsing, 4, Queen Victoria-street, E.C. ; F. Reeves, Springfield, Potter's Bar ; L. Maton, 21, Cannon-street, E.C. The number of directors is not to be less than four nor more than seven. The first are R. E. B. Crompton, W. Albright, G. Albright, J. Albright, and J. C. Howell ; qualification, £500 shares ; remuneration, £50 per annum each.

MEXICAN SOUTHERN RAILWAY (LIMITED).—Registered by Ashurst, Morris, Crisp and Co., 6, Old Jewry, E.C., with a capital of £1,000,000 in £10 shares. Object, to construct or acquire and equip, maintain and work railways, tramways, lines of telegraphs, telephones, or other means of communication or appliances of a similar nature in the Republic of Mexico ; to acquire mining powers, rights or easements over any railway, tramway, or line of electric wire ; to carry on the business of carriers of passengers and goods in all its branches by land and water, and that of transmitters of messages. The number of directors shall not be less than three nor more than nine ; the first to be appointed by the subscribers to the Memorandum of Association. Qualification, £250 stock. Remuneration, Chairman £1,000 ; other directors £400 per annum.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended May 3, 1889, amounted to £2,844, and for the week ended May 10 to £3,086.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the weeks ended May 3 and 10, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were respectively £1,939 and £2,147.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—The first general meeting of this Company will be held on Friday, May 17, at the Cannon-street Hotel, at 12 noon.

SUBMARINE CABLES TRUST.—In the report of the Submarine Cables Trust for the year ended April 15, it is stated that the balance of 7s. 6d. on the coupon due October 15, 1883, will be paid on the 15th instant.

THE BATH ELECTRIC LIGHT COMPANY.—The directors of the Bath Electric Light Company (Limited), whose registered office is at 2, Northumberland-buildings, have issued a circular in which they regret to state that the amount of share capital necessary for carrying out in its entirety the scheme of electric lighting for the City of Bath has not been subscribed. "It is," the directors add, "further to be deplored that this state of things has been brought about in a great measure by misrepresentation of facts on the part of those whose personal interests are supposed to be assailed by the introduction of the electric light. The matter is, however, so important to the citizens at large that the directors feel it incumbent upon them to state that unless at least £10,000 additional capital is applied for before the 27th inst. they will not feel justified in adopting the provisional contracts which would enable them to lay down the necessary plant for private lighting. The public lighting is, of course, already assured ; but in view of the generally expressed desire to have the means for private or internal lighting it is hoped that the citizens generally will see the necessity of subscribing to an undertaking which would supply this want."

REMOVAL.—"Wyman's Technical Series."—The publishing office of this valuable series of practical handbooks has been removed to 65 and 66, Chancery-lane, W.C.

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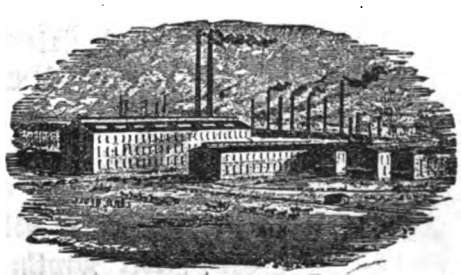

FACTORY.

FLEXIBLE, 2/- per lb. ; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, May 15, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 15, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	51½ 52½	3 16 2	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	25/0	Do. Preferred	87 88	4 10 11	" "	88	87½
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	18⅝	18⅛
130,000	£10	3/0	Brazilian Submarine	13¾ 14	5 0 0	Mar., June, Oct., Dec.	14 1/16	13 13/16
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 14¾	6 2 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19 20	5 0 0	" "	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3¾ 4½	4 4 8	March & September	...	...
6,000	5	5/0	Do. Preference 10%	8⅛ 9⅛	5 5 3	April and October	8¾	...
60,710	20	3/6	Direct United States	10⅝ 10⅞	5 3 6	Jan., Apr., July, Oct.	10 1/16	10 9/16
380,000	10	2/6	Eastern	13 1/16 13⅛	4 8 11	" "	13½	13¼
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15½	3 18 8	" "	15	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	106 108	3 14 1	May and November.	109	107
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	5/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct	13⅞	13½
300,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	...	...
471,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	3/0	Globe Telegraph and Trust	7⅛ 7⅜	5 6 5	Jan., Apr., July, Oct.	7⅝	7⅜
178,992	10	3/0	Do. 6 per Cent. Preference	14½ 14¾	4 1 4	" "	14⅞	14⅝
150,000	10	5/0	Great Northern	15¾ 16	4 13 9	Jan., July, and April	16	15⅞
17,000	25	2/6	Indo-European xd	39 41	6 1 11	April and October	39½	...
9,000	8	8/0	Reuter's	7 7½	5 6 8	April and October	...	...
15,609	10	3/0	West African Telegraph	8½ 9½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	100 103	4 17 1	March & September	102½	102
80,000	10	6/0	West Coast of America	10 10½	4 15 3	January and July	10⅜	10⅛
150,000	100	8%	Do. Debentures 8%	120 124	6 9 1	June and December	124	...
88,321	10	nil.	West India and Panama	2 2½	...	...	2⅛	2
34,563	10	12/0*	Do. 1st Preference 6% xd	11¼ 11⅞	...	April and October	12⅛	11⅝
4,462	10	†	Do. 6 per Cent. 2nd Preference	13 14	...	...	13½	...
45,181	15	6/0	Western Brazilian	12¾ 13¼	5 13 4	March & September	13 3/16	12 5/16
1,500	£1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
197,600	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	4½d.	Consolidated Telephone and Maintenance	⅞ 1⅛	...	Yearly	⅞	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 1	...	...	...
80,000	5	5/0	United	15¼ 16	4 13 9	June and December	16	15½
55,000	5	3/0	United River Plate	5⅞ 6⅛	...	January and July	6 1/16	6
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 3⅝	...	...	...	...
23,692	5	2/0	Do. (fully paid)	4 4½	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	2½ 3	...	...	2 13/16	...
			MISCELLANEOUS.					
87,350	12	36/0	Telegraph Construction and Maintenance	41 43	5 11 9	March and July	42½	42
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18 19	5 5 3	February & August	18⅝	...

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
J. G. Statter & Co., Limited.

MANVILLE & MADGEN, *Managing Directors.*

3, Prince's Mansions, Victoria Street, Westminster.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 575.—Vol. XXIII. FRIDAY, MAY 24, 1889. Price Fourpence.

NOTES.

With the report of Major Marindin we have dealt in another column, but there arises out of it incidentally a matter of great importance, to which we may refer in this place. The question whether or not an Order or a License is to be construed, in the absence of a contrary provision, as conferring a monopoly within the scheduled district during the period of its operation appears to have been tacitly decided in the negative. The districts of Chelsea, and of St. James, Westminster, which have been allotted to the London Company, are already occupied in part, the former under an Act obtained in 1886 by the Chelsea Electricity Supply Company, and the latter under a License granted last year to the St. James and Pall Mall Electric Light Company. For good or for evil, therefore, the principle has now been established that statutory powers under the Electric Lighting Acts convey no monopoly whatever.

The Paper read last night before the Institute of Electrical Engineers by Mr. W. M. Mordey on "Alternate-Current Working" was full of the liveliest interest from beginning to end; it is, indeed, seldom that the Institute has the opportunity of hearing a Paper embodying the results of so much practical research, and tending at the same time to overturn so many widely accepted beliefs. Mr. Mordey's Paper is equally remarkable for the fearless manner in which he presumes to differ from nearly all the guides, philosophers and friends who have preceded him in the treatment of the subject, and for the courteous, and, we may add further, the highly effective way in which he expounds his reasons for so doing. In the first place, Mr. Mordey has settled by direct and conclusive experiment the question of working alternators in parallel, and has shown that—contrary to all that we have hitherto been told—this is to be done by reducing to a minimum both the self-induction and the resistance of the armature. It will be remembered that the smallness of its self-induction and the rigidity of its field are features characteristic of the Mordey Alternator, and he has found that if two such machines are switched into parallel circuit under almost any conceivable conditions they will instantly fall into step. They may be giving widely different E.M.F.'s, they may be loaded or unloaded, their phases may at the moment be in opposition, they may even be driven by different engines at different speeds, and still (provided in the last case that one engine is not too powerful) they will instantly adjust themselves for parallel working. Mr. Mordey proceeds to show that this experiment also affords the solution of the synchronising alternate-current motor, which is well adapted for the transmission, though not perhaps for the distribution of energy.

The question of Periodicity is discussed at some length, the author giving his opinion in favour of a medium frequency of about 100. He has found that with this particular period his own transformers have a maximum efficiency—a fact of considerable theoretic interest, which will, however, bear further elucidation. In this section Mr. Mordey furnishes a valuable table, based upon Sir William Thomson's formula, and showing the virtual resistance of conductors of different diameter under periods of 80, 100, and 133. He also proposes a novel and simple method of determining the efficiency of transformers, which though demanding a good deal of time, is well adapted for commercial employment. It consists in determining the power in watts required in order that a direct current may raise the transformer to the same temperature as that at which it arrives when working in the usual way under the given load.

As we shall probably return to this subject after the discussion which takes place on Thursday next, we will content ourselves for the present with a bare enumeration of the remaining sections of the Paper, each of which contains much that is both novel and important. They are as follows:—The Secondary E.M.F. of Transformers; Alternate-Current Arcs; Safety and Safeguards; Hysteresis and Eddy Currents.

The second evening of the discussion on Dr. Lodge's Paper on Lightning Conductors gave rise to several speeches of an interesting character. Col. Armstrong, on behalf of the War Office, announced that they would be happy to supply the barrel of gunpowder for Mr. Preece's experiment. Mr. G. J. Symons thought that Mr. Preece, whilst grasping the rod, should be otherwise well insulated from earth. But on this point opinion seems to differ. Prof. Hughes referred to the experiments carried out in 1864 by Prof. Guillemin and himself with the view of determining the conditions under which a telegraph instrument, or its equivalent, could be protected from a Leyden jar discharge when the discharge was effected "with the utmost possible suddenness"—though since discharging tongs were used it is probable that this condition was not fully attained. Prof. Hughes found—and he is, we think, fully entitled to the priority of the discovery—that under the cir-

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cumstances of the experiment a thin iron wire was not protected even by the interposition in parallel of "a short, thick copper rod." A translation of the original Paper by Prof. GUILLEMIN, and a discussion on the subject between Profs. LODGE and HUGHES, appeared in *The Electrician* of July 13th, 1888. The difference between them seems to be that Prof. HUGHES is not inclined to draw the inference from the experiment that it would otherwise seem to warrant.

GREAT interest was taken in Mr. WIMSHURST'S experiments showing the difference in the behaviour of positive and negative electricity. It has been known for more than fifty years that between a small ball and a larger one a larger spark can be obtained when the smaller ball is positive than in the opposite case. FARADAY—who in 1838 refers to the fact as being already well known—made a careful study of the phenomenon (*Experimental Researches*, § 1,480, *et seq.*), and found that it depended in part upon the nature of the dielectric, and that in certain gases (N and H) the effect was reversed. He made use of an "analyser" similar to that shown by M. WIMSHURST. A good deal of information on the subject may also be found in "DE LA RIVE" (Vol. II., Ch. I., § 5, edition of 1854). But, so far as we know, before Mr. WIMSHURST no one had observed the remarkable difference in the protective power of points, according to the difference in the sign or direction of the discharge. Mr. WIMSHURST'S experiments plainly showed that under similar conditions a lightning conductor would afford protection when the clouds were negative, but not if they were positive. Mr. WIMSHURST'S observations on the increased tendency to side-flash due to defective earth were also of much practical importance.

IT is possible that some of our readers, on referring to the authorised report of the entire discussion, which we publish this week, may be inclined to think that our criticism of last week was a little unfair. We beg, however, to assure them that the explanation lies in the fact that while the report is authorised the criticism was not. The debate was left almost entirely in the hands of the older men, but we believe that the great majority of the younger school are inclined to attach more importance to the views of the author of the Paper than is generally entertained by the members of the Lightning Rod Conference. We may remark, in conclusion, that of those who alluded to the subject one speaker alone had not yet been able to make up his mind one way or the other on the relative suitability of iron or copper—this was Sir WILLIAM THOMSON.

ON Tuesday last the vote in the Supplementary Estimates amounting to £67,163, being England's share of the purchase money for the extinct Submarine Telegraph Company's property, was passed in Committee of the House of Commons after some rather severe criticism at the hands of Mr. HENNIKER HEATON, Sir G. CAMPBELL, and Mr. LABOUCHERE. Considering that the investment will probably yield a profit of £15,000 or £20,000 a year, these criticisms seem to us a little overstrained. It is true that the sale was not compulsory in the technical sense of the word; but as the Company were precluded from selling to anybody except the actual purchasers, and were forced to wind up their business, it is plain that the sale was compulsory in the sense of not being voluntary, the alternative being that of making the country a present of plant and buildings worth at least £60,000. One other alternative there was which critics like *The Times* and Mr. HENNIKER HEATON entirely lose sight of—the Company might have taken up its cables, stuck to its central office, and sold its repairing ship. Had they done this, which they were certainly entitled to do, the Governments would have been hard put to it, and the telegraphing public seriously inconvenienced. Both parties, therefore, at length agreed to what may be fairly called a compromise. If either of them has reason to complain it is certainly not the purchasing party.

WE describe elsewhere some interesting modifications which have been introduced by Prof. ELIHU THOMSON into the type of oscillating meter first designed by Mr. TAVERNER (extracts from whose patent, No. 123, 1884, will be found in our issue of December 16th, 1887; see also *Electrician*, May 25th, 1888, p. 70). The object of Prof. THOMSON'S device is to render the indications of the instrument directly proportional to the current. We believe, however, that Mr. TAVERNER has succeeded in accomplishing the same thing by more simple means.

THE report of the Electric Lighting Committee of the Bedford Town Council is, upon the whole, a business-like and satisfactory document. The practical and financial success of the Thomson-Houston station at Taunton seems to have created a strong impression upon the minds of the Bedford Committee; though, in preference to leaving the work in private hands, they recommend the Council to establish a station on their own account. In the scheme submitted it is proposed to replace 228 gas lamps by 100 arcs of 1,200 candle-power, and to provide for 4,500 incandescents for private lighting. Upon the basis of an average income of 10s. per lamp from the latter source the Committee hopes to effect a net saving of £345 per annum over the present cost of lighting the streets. The estimates furnished are scarcely in sufficient detail to permit of useful criticism, but they are probably not very wide of the mark—they are certainly much more reasonable than some others which it has fallen to our lot to notice. Nevertheless, some of the minor items are clearly under-estimated. In the capital account we find the entry: "Wire (7 miles), £434." This being the only entry for conductors, it presumably includes the incandescent network as well as the arc circuits; and since it does not appear that any kind of transformer system is contemplated, the figure is certainly much too low. It is true that the arc-lighting circuits are to be overhead, but these alone will cost at least £150 without posts, whilst the low-tension circuit will probably cost considerably more than this *per mile*. Another item to which we are bound to take exception is that of salaries and wages, which is put down for £450 per annum. This sum would barely pay the wages of engine-drivers, stokers, lamp trimmers, and lineman (except

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the last, two of each class would be wanted), and nothing is left for the electrician in charge. For a station of this order it would certainly be far cheaper in the long run to get a competent man, and to pay him a salary of, say, £250 per annum. When these corrections are made, possibly it will be found that the greater part of the anticipated saving will have vanished; but even so Bedford may well be congratulated on the wisdom of the policy which its Councillors have in contemplation.

In his interesting Paper, "On the Street and Railway Traffic of the Metropolis," recently read before the Society of Arts, Mr. J. Stephen Jeans, while paying the conventional tribute to the possibilities of electricity as a future source of motive power, is apparently somewhat diffident of its present capabilities in this direction. After showing in the most conclusive manner the urgent necessity of relieving our overcrowded streets, Mr. Jeans suggests, amongst other remedies, the establishment of a system of overhead railways, remarking that "there are strong objections to the increase of underground ways of communication." On this point there can, of course, be little difference of opinion, if we are to assume that the present method of working the Underground Railway is to be persisted in for all time. But it is on the very ground that the employment of electricity would reduce vibration to a minimum, owing to the absence of heavy reciprocating parts, and would render the atmosphere of the tunnels somewhat more breathable, that electricians are sanguine that in the adoption of electric traction lies one of the most hopeful solutions of the municipal rapid transit problem as it presents itself in this city. With the Inner Circle worked by electricity, and with the principal points on opposite sides joined by electric subway railways, such as the one now before the House of Commons, we fail to see what objections could be urged against underground railways which would not apply with tenfold force against any system of overhead lines. If the present possibilities of electric traction were more carefully considered, and if the future was left to take care of itself, we think it would be all the better both for electric traction and the public generally. We regret to notice in this relation that the Select Committee of the House of Commons yesterday threw out the London Central Subway Railway Bill, which sought powers to connect Piccadilly with Holborn Circus by means of an underground railway.

King, Brown and Co. *v.* Anglo-American Brush Corporation. This case again came before the Scotch Courts on Wednesday last, and the proceedings will be reported in our next issue.

Obituary.—*Indian Engineering* announces the death at Darjeeling of Mr. W. P. Johnston, Government Electrician of Calcutta, a distinguished officer in the scientific branch of the Telegraph Department.

Sunderland.—The Town Clerk of Sunderland has received formal notice from the Sunderland and District Electricity Supply Company of the intention of the Company to apply to the Board of Trade for a Provisional Order.

Greenwich.—The Greenwich Board of Works have affixed their seal to an agreement between the Board and the London Electric Supply Corporation (Limited), whereby permission is accorded for the laying down of three-inch mains at Deptford.

The Seel Lamp.—According to the *Bulletin des Adjudications*, both the Edison Company and Messrs. Siemens and Halske have commenced legal proceedings against the company which was started in Germany to work the Seel incandescent lamp patents, and claim heavy damages.

Extension of Electric Lighting at Blackpool.—The Blackpool Corporation have decided to extend the electric lighting on the beach from the South Pier almost to the bottom of South Shore. The contract has been awarded to Mr. Thomas Barton, of Ainsworth-street, Blackburn.

Volta's House.—The cottage in the little village of Lazzate, in which Alessandrio Volta spent the summer and autumn months of many years, pursuing the investigations which resulted in the discovery of the voltaic pile, has been secured as public property, and is now adorned with a tablet bearing an inscription.

Woodward Storage Battery.—A correspondent, writing from the States, says:—"The American Company, owing to increased demand for the Woodward plate, have enlarged their works at Detroit, and have now facilities for turning out 1,000 complete cells per day. A company is in formation at Toronto to work the Canadian patent."

Burton-on-Trent.—The Gas Committee of the Burton-on-Trent Town Council recommended, at the last meeting, that the Gas Manager should be instructed to obtain plans and specifications with a view to the introduction of an installation of electric light, for the purpose, if found advisable, of lighting a portion of the borough by electricity.

Tramway between Brookwood and Bisley Common.—The South-Western Railway Company is about to construct a tramway from Brookwood Station to Bisley Common, the site of the "new Wimbledon." The tramway will be about one mile long, and it is to be hoped that the company will not overlook the suitability of electric traction for such a line as this.

A 100 Horse-Power "Otto" Gas Engine.—We learn that Messrs. Crossley Brothers have just finished the second of a pair of double-cylinder engines of 100 horse-power for a large paper works at Godalming. These engines, which are, we believe, the largest ever yet made to be driven by gas, are guaranteed to work with a consumption of 1½lb. of coal per horse-power per hour.

Dundee.—Mr. W. Ogilvy Dalgleish, of Errol Park, has given the committee of the Albert Institute the sum of £1,000 to enable them to extend the electric light to the lending and reference libraries. These rooms are very crowded at night, and the introduction of the electric light is an improvement which the committee had long desired, but were unable to carry out owing to want of funds.

The Claude Telegraph Apparatus.—After eight months' trial, the Paris-Lyons and Mediterranean Railway Company has decided to definitively adopt the Claude apparatus. The towns at present served by this instrument are Paris, Moret, Laroche, Les Laumes, Dijon, Persigny, Chagny, Châlon, Mâcon, Lyon-Vaise, Lyon-Perache. The line is 511 kilometres in length, and the wire used is 3 millimetres in diameter.

Soirée of the Architects' Association.—At the recent *soirée* of the Architects' Association gas could not be used for the footlights owing to insurance. The difficulty was, however, overcome by lighting the stage with incandescent lamps run off accumulators, an adjustable resistance being inserted in circuit so that the brilliancy of the lamps could be varied as desired. This installation was undertaken by the Acme Electric Works.

Ship Lighting.—We learn that Messrs. Paterson and Cooper have recently fitted with the electric light the screw steamers "Islander," "Curfew," "Ardle," "Dundee," "Cambria," "Pladda," "Dean," and "Modjeska." They have also fitted the steam yacht "Tighramara," belonging to Mr. Allan, of the Allan line of steamers, accumulators being in this case employed. The firm has several additional ship installations on hand.

Institute of Electrical Engineers—Students' Meeting.—At a meeting held on Friday, May 17, Mr. Sydney Evershed, A.I.E.E., in the chair, a Note was read by Mr. R. W. Paul, on "Increasing the Fog-Penetrating Power of the Arc Light,"

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and a Note by Mr. J. N. Cooper, on "Equipotential Surfaces." A discussion followed, in which Messrs. Yeaman, Horn, and the Chairman took part. A vote of thanks to Mr. Evershed closed the proceedings.

Folkestone.—The Folkestone Town Council have decided to support Messrs. Crompton and Co. in an application for a License to supply the electric light to private consumers, and, with a view to lighting the public thoroughfares with the electric light, have given the Gas Company notice of termination of contract. Messrs. Crompton purpose to commence to supply the light in August next, and the contract with the Gas Company terminates in July next year.

Underground Telegraph Line between Washington and Boston.—The Spaulding Telegraph Company are engaged in running an underground telegraph line between Washington and Boston, with branch lines to Baltimore, Philadelphia and New York. The cables, 75 to 160 in number, will be placed one foot under the ground in iron pipes 6in. in diameter. It is anticipated that this service will be less liable to interruption than the overhead one.

The London Central Subway Bill.—On Wednesday last Sir Frederick Bramwell was called as a witness before Mr. Woodall's Select Committee on the London Central Subway Bill. Sir Frederick Bramwell opposed the Bill on the ground that the route was not well selected, and that the electrical plant estimated for by the promoters would be insufficient, and that if adequately increased the working expenses would in consequence be greater than anticipated.

Weybridge.—For the last few nights a small number of incandescent lamps of various candle-power have been lighted in the streets of Weybridge, in order to give the lighting inspectors and others interested in the proposed lighting scheme an opportunity of forming an opinion as to the suitability of these lamps for outdoor purposes. The current was supplied from the dynamo at "Moorcroft," Mr. J. B. Verity's residence, and the light gave general satisfaction.

Glass Tube Conduits.—Experiments are being made on the Continent with a novel form of conduit for underground mains. The conduit consists of a glass tube, protected by a thin coating of specially prepared cement, and enclosed in a cast-iron pipe, the iron being run on hot. Bare conductors can then be used, and it is asserted that not only is the insulation very high but that the conduit is cheap and perfectly air-tight. How the difference between the coefficient of expansion of glass and iron is accounted for we are at a loss to understand.

Lighthouse Illuminants.—Ever since the Trinity House report on the South Foreland tests of lighthouses illuminants was published, an agitation has been carried on by those interested with a view to reopening the question then supposed to have been finally settled. The result of this agitation has been that a committee of the Royal Society, composed of the President, Prof. Stokes, Sir William Groves, and Lord Rayleigh, has been appointed to decide whether the conclusions of the Trinity House are justified by the results of the experiments made.

Franco-Italian-Swiss Telegraph Convention.—The French Italian, and Swiss Governments have agreed to consider their agreements of 1880 as always in force. By the arrangement then concluded it was agreed that whenever the ordinary telegraph lines between any two countries were interrupted messages should be allowed to pass over the lines of the third country without payment. This arrangement applied to telegrams to Corsica and Sardinia, with the reservation that gratuitous transmission was only to last for six months at the most.

The Electric Light in the South African Gold Mines.—The mine and stamps of the Robinson Gold Mine (Transvaal) are lighted by the electric light. When one considers that the £1 shares of this company have recently stood at £60 each, and that the chairman estimates a net profit of £1,620,000 per annum, whereas the total capital of the company is at present but £50,000, the shareholders can hardly consider the installation as an extravagant piece of expenditure. On the other hand, since the electric light has been introduced the mine has, we understand, been worked night and day with a corresponding large increase in output and profit.

A Safe Method of Transporting Sulphuric Acid.—Herr Bickmann has patented in Germany a process for enabling sulphuric acid for manufacturing purposes to be safely transported. He takes advantage of a property of certain salts—of which alkaline sulphates are representatives—by which they give up their water of crystallization when heated and take it up again when cool; and he does so by mixing these salts in an *anhydrous* condition with a calculated quantity of sulphuric acid. The whole mass becomes granular, or may be formed into cakes; and when heated the whole liquefies and may be used as if it were sulphuric acid, for the presence of bisulphate of soda does no harm.

Another Electric Railway Proposed.—On the invitation of some of the leading gentlemen in Brechin, Mr. A. R. Bennett addressed a public meeting in that town on May 16 on the subject of electric railways, and more especially in connection with a proposed line from Brechin to Edgell, a distance of six miles. There was a large attendance, and the meeting resulted in the appointment of a committee consisting of Provost Mitchell; Mr. Shiel, factor to the Earl of Dalhousie; Mr. Lamb, manufacturer; Mr. Valentine; Mr. Anderson and Mr. Philip, Bank of Scotland, to procure estimates and approach the proprietors whose land is required, with a view of avoiding, if possible, the necessity of an Act of Parliament.

Electrolytic Assay of Copper.—In estimating copper electrolytically, Herr F. Rüdorff says:—"It is advantageous to acidify the solution with nitric acid; but when chlorides are present considerable time is taken up in evaporating the solution with sulphuric acid. He found that when an ammoniacal copper solution is electrolised the metal separates in a spongy condition, but that if 2 to 3 grams of ammonia or potassium nitrate be added, and then about 10 cc. of ammonia for every 100 cc. of the solution containing 0·1—0·3 grams of metal, the latter separates in excellent condition, even when the strength of current enployed varies between considerable limits. The operation is at an end when the solution has become colourless."

The Telephone in Spain.—We reproduce from the *Anales de la Electricidad* of Barcelona the following list of telephone exchanges at present in operation in Spain, namely, Alcoy, Alicante, Barcelona, Bilbao, Cadiz, Carthagena, Cordova, Corunna, Felanitx, Gijon, Madrid, Malaga, Murcia, Oviedo, Sabadella, Sebastian, Segovia, Seville, Valencia, Valladolid, and Saragossa. These 21 exchanges have a total of 4,585 subscribers, or an average of 218 each. Madrid heads the list with 1,458, Barcelona comes next with 774, while St. Sebastian comes last with the modest number of seven subscribers. The following towns will shortly be provided with telephone exchanges:—Almeria, Castellon, Grenada, Xerez, Linares, Manresa, Palma, Santander, and Vigo.

The Purchase of the Submarine Telegraph Company's Cables, &c.—In the House of Commons on Tuesday the vote was agreed to, amounting to £67,163, for the acquisition of the Submarine Telegraph Company's property. For the two cables between England and Belgium £9,900 was required, and for the four cables between England and France, including one between France and Jersey, £18,400. Part of these sums would be recovered from France and Belgium, who are partners in the transaction, as appropriation in aid, so that £14,150 would be contributed. A sum of £24,679 was to be paid for the 80 years' lease of the building in Throgmorton-avenue, £9,542 for apparatus, £9,570 for the cable ship "Lady Carmichael," and £5,500 awarded as bonus to retiring officers of the company.

Opening of a Telephone Exchange at Berwick.—On Monday, the 6th inst., a number of business men and others met at the offices of the Northern District Telephone Company, in Woolmarket, for the purpose of formally opening a telephone exchange there. Mr. C. B. Clay, manager of the company, after describing the working of the telephone, with practical illustrations, alluded to the growth of the company's system as compared with that of the Post Office. During the period in which the Northern District Company had added 130 subscribers to

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their system the Post Office total had been reduced by two. At present the Post Office had 1,300 subscribers, and the company 13,000. Mr. Darling (county Alderman) then declared the exchange open for business. The subscribers to the Berwick exchange are at present 18 in number.

Portsmouth.—On Monday afternoon last a private meeting was held at Portsmouth for the purpose of discussing a proposal for the introduction of the electric light. Mr. R. W. Ford, in the course of some introductory remarks, said the light had already been adopted successfully at Eastbourne, Brighton, Kensington, and other places, and a proposal had been submitted on behalf of the House-to-House Company to establish at Portsmouth a station for supplying the light throughout the borough. The opinion in favour of the light was unanimous, though some of those present thought that the undertaking should be entirely in the hands of the Corporation. It was stated that a company would be started with a capital of £50,000, of which about one-half only would now be called up.

Submarine Telegrams.—In the House of Commons on Friday last Mr. Goschen, in answer to Mr. Henniker Heaton, stated that about £16,000 was expended during the year ended March 31, 1889, on submarine telegrams from England to foreign parts by the various Government departments. Last year's votes showed that the amount paid by the British Government for telegraph cable subsidies was £49,000. He understood that the Eastern Extension Company had laid two cables to Australia. The one which was laid first was unsubsidised, but the Australian Colonies pay an annual subsidy of £32,400 for the second. No contribution was made from Imperial finances. He could not say that he was prepared to consider the advisability of appointing a Commission to consider and report on the whole question of telegraphic communication between England and the various parts of the empire.

The Association of Agricultural Engineers of Great Britain and the Paris Exhibition.—The following circular has been issued by the above association :—

The Associated Agricultural Engineers in Great Britain having resolved not to exhibit their machinery at the forthcoming Paris Exhibition, we feel it our duty, in announcing the fact to our friends and business connections, to state briefly the reasons which have prompted this decision. It is well known that it has been our general practice to take part in all the great Exhibitions throughout the world since their commencement in London in 1851, and, as a body, we have spent more upon such Exhibitions than any other class of manufacturers. It is not merely a question of expense which causes us to refrain from taking part in the Paris Exhibition, but the conditions and regulations of the French Executive Committee under which we were invited to exhibit were of such a nature as would not permit us to do justice to ourselves or to the branches of engineering industry we represent. The facilities for exhibiting offered us were in our judgment totally inadequate, and left us no option but to decline sending our machinery. The names of the firms who have adopted this resolution are as follows :—

The Albion Ironworks Co.
Barford and Perkins.
Barrows and Co.
Bentall and Co.
Bristol Waggon Co. (Limited).
Burlingham, Innes and Co.
Clayton and Shuttleworth.
Coleman and Morton.
Cooke and Sons.
Corbett, Thomas.
Crosskill and Sons.
Foster and Co. (Limited).
Fowler and Co. (Limited).
Garrett and Sons.
Gibbons and Robinson.
Holmes and Sons.
Hornsby and Sons (Limited).
Howard, J. and F.
Humphries, E.
Hunt, R., and Co.
Jeffrey and Blackstone.
Keyworth, J. and H., and Co.
Lister and Co.
McLaren, J. and H.
Maldon Ironworks Company (Limited).
Marshall, Sons and Co. (Ltd.)
Nalder and Nalder (Limited).
Nicholson, W. N., and Son.
Page and Co. (Limited).
Penney and Co.
Picksley, Sims and Co. (Ltd.)
Rainforth and Son.
Ransomes, Sims, and Jefferies (Limited).
Richmond and Chandler.
Robey and Co.
Ruston, Proctor and Co.
Savage, F.
Turner, E. R. and F.

An Electric Wagonnette.—At the Kent County Council on Tuesday, Mr. Links, of Kent House, Sydenham, made application for permission to run a wagonnette propelled by stored electricity over the roads in Kent. The applicant stated that the vehicle would not differ in appearance from carriages drawn by horses, and it would weigh half-a-ton. He would take out an Excise license for the vehicle. The Clerk to the Council stated that the vehicle would have to be licensed under the Locomotives Act, and the Council would not prohibit its use. By the provisions of the Locomotives Act the license would be required to hire a man to walk in front of the carriage with a red flag. He then can "travel" about three miles an hour, a leisurely mode of progression which would enable him to examine the country thoroughly. If he should "travel" at a greater speed he becomes amenable to the law, and liable to heavy penalties.

The Proposed Telephone Convention.—The following circular has been issued by the Committee of the forthcoming Telephone Convention :—

"Dear Sir : A Telephone Convention for the interchange of views on practical telephone work has been organised by the representatives of the Telephone Companies and the Post Office. It will be held in London on the 11th, 12th, and 13th of July next.

"The Committee are of opinion that the success of the Convention will be enhanced by the presence of those engaged in the manufacture of apparatus and appliances used in connection with telephone work.

"The Committee hope that it will be convenient to you to attend.

"In connection with the Convention it is proposed to hold an exhibition of apparatus and appliances. Should you desire to exhibit, the Committee will be obliged by your communicating with the Acting-Secretary, Dr. Julius Maier, 23, Melrose-gardens, West Kensington Park, W., stating the nature of your proposed exhibit, so that the necessary arrangements may be made.—Yours faithfully,

"Julius Maier."

The following are the members of the Committee :—Mr. James Brand, Colonel Jackson, Messrs. W. H. Preece, C. W. Fitzgerald, Owen Unwin, T. Fletcher, J. E. Kingsbury, and Dr. J. Maier.

Birmingham Electric Lighting.—The *Birmingham Daily Post* has the following :—"At the commencement of the present year the Birmingham Town Council were occupied in the consideration of a report of the General Purposes Committee upon the application of Messrs. Chamberlain and Hookham for a Provisional Order to authorise a scheme of public and private electric lighting. The promoters of the Order sought to obtain a concession of the entire city, but the General Purposes Committee could not see their way to consent to this, and sought to limit the Order to a restricted area, composed principally of Market Hall Ward. They also desired that the promoters should be required to form a company with at least £50,000 capital—a sum to which the promoters would only consent if the entire area of the city was included in the Order. Upon the Council adopting the recommendations of the committee, it was generally understood that the promoters regarded their requirements as placing insuperable difficulties in the way of the scheme, and that the latter was therefore abandoned. We are glad, however, to learn that the scheme is still in existence, and that there is a reasonable probability of its being carried into effect. Messrs. Chamberlain and Hookham have not withdrawn from the promotion of their Order, which, after various communications with the Board of Trade and the General Purposes Committee, has practically arrived at its final form. The Board of Trade consider the area suggested by the Corporation a reasonable one, and they have also set down the capital to be provided at £50,000. The committee have submitted that this amount ought to be £100,000, but, not wishing to give any colour to the idea that they desire to hinder the adoption of electric lighting in the city, they have, acting under the authority given to them by the Council, consented that the Provisional Order shall stipulate for £50,000 only. They have also given way upon some matters of working detail, and on Monday, at a fully attended meeting of the committee, approval was given to the draft order as amended by the Board of Trade. It now remains to be seen whether Messrs. Hookham and Chamberlain will take up the Order under its present conditions. There is reason to believe that they will do so, especially in view of the fact that if the Order as now offered by the Board of Trade is not accepted some other promoters will find everything ready to their hand if next year they should be prepared to give notice to obtain an Order in the same terms."

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REPORT OF MAJOR MARINDIN ON THE BOARD OF TRADE INQUIRY INTO THE LONDON PROVISIONAL ORDERS.

The following is the text of Major Marindin's report:—

Railway Department, Board of Trade,
1, Whitehall, London, S.W., 9th May, 1889.

SIR: I have the honour to report, for the information of the Board of Trade, that in compliance with the instructions contained in the Order of the 14th March, 1889, under the Electric Lighting Acts of 1882 and 1888, I have held an inquiry in reference to the applications under the said Acts for the following Provisional Orders and Licenses, viz.:—

Title of Order.	Name of Promoters.
Belgravia Electric Lighting Order.	Chelsea Electricity Supply Co. (Lim.)
House-to-House Electric Light Supply Order.	House-to-House Electric Light Supply Co. (Limited).
Kensington and Knightsbridge Electric Lighting Order.	Kensington and Knightsbridge Electric Lighting Co. (Limited).
London Electric Supply Corporation Electric Lighting Order.	London Electric Supply Corporation (Limited).
Metropolitan Electric Supply Co. (Mid-London) Lighting Order.	Metropolitan Electric Supply Co. (Limited).
Metropolitan Electric Supply Co. (North London) Lighting Order.	Do. do.
Metropolitan Electric Supply Co. (South London) Lighting Order.	Do. do.
Metropolitan Electric Supply Co. (West London) Lighting Order.	Do. do.
Notting Hill Electric Lighting Order.	Notting Hill Electric Lighting Co. (Limited).
Paddington Electric Lighting Order.	Electrical Power Storage Co. (Lim.).
St. Martin's and Strand Electric Lighting Order.	Electrical Power Storage Co. (Limited).
South Kensington Electric Lighting Order.	Chelsea Electricity Supply Co. (Limited).
Westminster Electric Lighting Order.	Westminster Electric Supply Corporation (Limited).

Title of License.	Name of Promoters.
South Kensington Electric Lighting License.	Chelsea Electricity Supply Co. (Limited).
House-to-House Electric Supply License.	House-to-House Electric Light Supply Co. (Limited).

The North London Order of the Metropolitan Electric Supply Company was abandoned, and others of the Orders were considerably modified as to areas during the course of the inquiry.

In addition to the above applications, I was upon March 29, 1889, ordered to include in the inquiry and to report upon a Bill promoted by the Metropolitan Electric Supply Company (Limited), and entitled, "A Bill for authorising the Metropolitan Electric Supply Company (Limited) to erect and maintain Electric Lights and Works, and to supply Electricity within the Parishes of St. James's, Westminster, and St. Martin-in-the-Fields, in the County of Middlesex, and certain other Parts of the Metropolis, and for other Purposes."

The inquiry was held in the Town Hall, Westminster, was opened upon Wednesday, April 3, and was concluded upon Wednesday, May 1, the sittings having actually occupied 18 days. I also devoted the whole or part of three days in inspections of the works, and proposed sites for works, belonging to the different companies.

I have had during the inquiry the valuable assistance of Major Cardew, R.E., the Inspector of the Board of Trade for Electricity, who has advised me upon all scientific and technical details.

[The report next proceeds to furnish full details respecting the various Orders and Licenses. This information has, however, already appeared in our columns; we therefore omit it for the present in order to find room for the more material portion. We hope, however, to reprint this section of the report for convenience of reference in a succeeding issue.]

SYSTEMS OF SUPPLY.

Inasmuch as the several companies applying for Orders are for the present more or less committed to the supply of electricity by one or other of several different systems, although they would be by the terms of the proposed Orders actually bound to no system in particular, and would no doubt at some future time be driven to adopt whichever might be found to be the best, it is necessary to consider first the relative advantages and disadvantages of the different proposed modes of supply.

This question was the one which was most keenly contested at the inquiry, and the great bulk of the evidence was directed far more to the attack and defence of the rival systems than to the question of competition, or to the size of area, which, however, should depend greatly upon the system used.

The systems proposed are:—

1. The supply by means of high pressure alternating currents and transformers, which system may be subdivided into two heads, viz.:

(*a*) The system adopted by the London Company, viz., the supply from one large generating riverside station outside the crowded districts of the Metropolis, with trunk mains carrying the currents at the unprecedentedly high pressure of 10,000 volts, to transforming stations inside or near to the area of supply, whence the current will be taken in distributing mains, with a pressure of 2,500 volts, to the consumer's premises, or to secondary distributing stations, there again to be transformed to a pressure of 100 or 50 volts;

(*b*) The system adopted by the Metropolitan and House-to-House Companies, viz., the supply from a number of generating stations in or near to the area of supply, with distributing mains carrying the current at a pressure of from 2,000 to 1,000 volts to the consumer's premises, or to distributing stations, where, as in the case of the London system, it will be transformed to a pressure of 100 or 50 volts.

2. The direct supply by means of continuous currents, which may be dealt with under three heads:—

(*a*) The system adopted by the Chelsea Company, viz., the use of one generating station for a considerable area, and the charging with a pressure of from 1,000 to 2,000 volts several accumulator stations, with duplicate sets of batteries, at different points within the area of supply. The supply mains leading from these accumulator or distributing stations will carry current directly into the consumer's premises at a pressure of 100 volts, the supply being entirely from accumulators. The charging and discharging of the same set of accumulators cannot be carried on at one and the same time, so that it will be necessary to charge the batteries during the hours when there is little or no demand for current.

By the use of additional mains it would be possible to supply direct from dynamos at the generating stations when not charging, but it is proposed for the present to furnish the whole supply from accumulators. One set of these is charged at a time, the other set in the meantime meeting whatever demand there may be. The shifting over of the batteries from charging to supplying is effected by an automatic arrangement.

(*b*) The system adopted by the Kensington and Knightsbridge Company, which is at the present moment supplying partly by accumulators and partly by dynamos, the former doing the whole work during the hours of minimum supply, and the latter being employed in charging the batteries, and supplementing the direct supply from the batteries during the hours of maximum supply. This system, which other companies, viz., the Notting Hill Company and the Westminster Company, propose to adopt, would in a large area require several generating stations.

(*c*) The system adopted by the St. James and Pall Mall Company, which has commenced to supply under the terms of a License in the parish of St. James's. This is the simple direct system at low pressure, without any accumulators, and according to the evidence it is useful only for small areas with a radius not exceeding half a mile.

This system would therefore require a very large number of generating stations if adopted for large areas.

The relative advantages and disadvantages of the high-pressure transformer system and of the direct system as used by the Chelsea Company are thus concisely stated by Major Cardew, who bases his remarks upon the evidence given at the inquiry:—

"The transformer system carries the high pressure up to the houses. The distributing mains, therefore, are of small size. A large district can be served from one station, and the regulation of pressure in the distributing mains can be very good. There should be no great difficulty in maintaining a standard pressure within a variation of 2 per cent. The pressure in the houses may be different in different cases, according to the needs or fancy of the consumer.

"It is also a simple system to work, and the dynamos are simple, and can be made in easily replaceable parts.

"On the other hand, the high pressure necessitates great care and expense in insulation; the conveying of this high pressure to, at any rate, one point on the consumer's premises, and the risk of a contact between this circuit and the low-pressure circuit inside the house, involves some risk to life, although it may be reduced to a minimum by proper regulations and precautions; the main cannot be handled or connections made when the pressure is on; the re-

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gulation in the houses is not so good as in the mains, as the transformers act as a considerable added resistance, and cause an increased variation of pressure in the power as compared with that in the mains; the system cannot at present be efficiently utilised for motive power, or for electric deposition or other chemical uses, such as charging accumulators; and it is very doubtful whether a practically successful alternating motor is likely to be brought out; the system depends entirely on running machinery, and engines and dynamos have to be kept in motion throughout the 24 hours; the general efficiency must be low when the supply is near its minimum, a condition which, so long as it is utilised for lighting alone, obtains during about 18 hours of every day on the average, and a serious accident in the generating station might stop the supply for a considerable time. Alternating machines cannot be so readily connected together to run in parallel circuit as continuous current machines. The measurement of alternating current, pressure, and power also offers considerable difficulty, and the available instruments and methods are far more restricted in number than is the case with the corresponding quantities in continuous supply.

"The Chelsea system has the advantage of high pressure between the generating and distributing stations, without its being brought into the consumer's premises, and the distributing stations may be so numerous that each one serves only a small district, and in this way the size of distributing mains may be kept down; the supply from batteries has these enormous advantages: that in the event of a total breakdown at the generating station supply can still be maintained for some hours; that it is not necessary to keep the machinery at the generating station in motion throughout the whole 24 hours, and that the batteries provide a supply for the long hours when very little is required; the system has the advantages of continuous currents, viz., applicability to the supply of motive power, and other uses besides light and heat, and greater ease of measurement. The regulation, with small areas supplied from each substation, should be very good, and there is no doubt that a battery current is less destructive to lamps than one supplied from dynamos, whether alternating or continuous.

"On the other hand, the cost of the batteries is very great, and also that of the skilled attention they require, while their efficiency at maximum output is probably rather low; the automatic switches are a weak point, and any failure in this action would probably ruin the batteries at that station; the insulation of large batteries cannot be maintained at all high, and the numerous joints, in the presence of acid fumes, are a source of weakness.

"This system, in which the supply is entirely from accumulators, if it can be successfully worked in practice, possesses very great advantages. Unfortunately it cannot be forgotten that identically the same system was tried a few years ago at Colchester, and ended in disastrous failure."

The principal objections which have been urged against the London Company's scheme specially are as follows:—

(*a.*) That having only one generating station an accident might stop the whole supply.

That an accident, such as the bursting of one of the large steam-pipes, might have this effect is certain, for even if it did not kill or injure those in charge of the machines it would fill the whole building with steam, which would greatly impede, if it did not entirely prevent, the necessary work of the station from being for some minutes carried on, and would, I am advised, by condensing on the dynamos, switches, &c., working at very high pressure, possibly cause an electrical breakdown. The risk of such an accident, or any serious accident to the running machinery, might no doubt be provided against by a proper system of inspection and testing, and so far as the filling of the building with steam, and risk to life from the bursting of a steam-pipe, is concerned, the ill effects might be minimised by covering in the pipes, but the result of any cessation of work for even a few minutes at a generating station, upon which the supply of a very large area is solely dependent, would be so serious that I consider that it will be necessary to require that the company shall, to the satisfaction of the Board of Trade, so subdivide the station at Deptford as practically to provide two distinct generating stations, or shall forthwith establish a second generating station in some other locality. In either case there should be duplicate sets of mains led by different routes to each of the distributing stations in the area of supply.

(*b.*) That the great length of the trunk main increases the chance of a breakdown, and that the pattern of main proposed, with its numerous joints, is unsatisfactory.

This is a question which, no doubt, merits the serious attention of the Board of Trade, but it is one which I have no reason to believe would not be satisfactorily dealt with by proper regulations.

(*c.*) That the proposed pressure of 10,000 volts is so enormously in excess of anything which has hitherto been worked with that the scheme is a gigantic experiment.

No doubt in a certain sense this is true, but it must not be forgotten that whereas a few years ago the pressure of some 200 volts was considered to be the limit of safety, this Company has for some time been working, safely and successfully, at a pressure of more than ten times this amount, and as the so-called experiment of still further raising the limit of pressure would, if successfully carried out, be of immense benefit both to the public and electric lighting undertakers, I do not consider that, under proper regulations, the London Company should be prevented from carrying out a scheme in which they have shown the greatest confidence, and which the majority of the scientific witnesses who have been called approve of in principle.

(*d.*) That the telegraphic and telephonic service of the Metropolis will be seriously interfered with.

This difficulty ought to be easily met by proper regulations and proper clauses in the Order.

On the other hand, the system of the London Company possesses the undoubted advantages over any others, which arise from the location of the generating station on the riverside, and the consequent removal from the crowded parts of the Metropolis of all inconvenience from noise, vibration, smoke, and heavy traffic.

It will probably also be found that from the economy resulting from the concentration of plant, the facilities for getting a cheaper supply of coal, and the possession of large storage capacity upon the premises, the cost of production under the London system will be largely reduced, to the eventual benefit of the consumer.

Of the scientific witnesses called as to the relative merits of the two systems of supply the great majority were in favour of the alternating transformer system for large areas

There can, however, be no doubt that from a consumer's point of view, leaving the question of price out of consideration, the supply made by such a company as the Chelsea, viz., from accumulators alone, is the most valuable, and that the supply by means of all the direct systems has this advantage, that it can be utilised for power, which cannot at present, at any rate, be said of the supply given by the transformer system.

It would therefore be wisest, in my opinion, to give fair scope to all the proposed systems, all of which are capable of being worked; and it may be predicted with tolerable certainty that whatever system proves itself to be the best under all circumstances will eventually be adopted by all.

Conclusions.

After a careful consideration of the above points, and of all the evidence and arguments put before me, I have arrived at the following general conclusions:—

(1.) That it must be admitted that the science of electric lighting has now reached the point at which a supply can be made which will be of very great benefit to the public, and that the power of obtaining this supply should be within the reach of all persons who may require it. For this reason it seems to me that although the wishes and opinions of the local authorities in the areas proposed to be supplied should be consulted and deferred to as far as possible, the mere objection by a local authority to the introduction of a company proposing to supply electric light upon general grounds should not be considered sufficient to exclude such company, unless the local authority should express its intention to undertake the supply, and give evidence that it proposes to apply for permission to do so, and this should apply with more force when it can be shown that the exclusion of a company from such an area would injuriously affect the service of other contiguous areas.

(2.) That in dealing with this question it should be considered as one affecting the interests of the Metropolis as a whole, and as an area which at no very distant time may be for purposes of lighting and management of roads and streets under the control of one central authority; and that, therefore, the whole of the Provisional Orders granted for the Metropolitan area should, as far as possible, be identical in form, with identical provisions as to supply, compulsory powers, interference with streets, and more than all, as to price.

In my opinion the scheme adopted in 1883 of dividing the area of supply into two areas (A) and (B) would not be likely to work so much to the advantage of the public as the proposal in most of the Orders under consideration to make the supply compulsory under requisition over the whole area upon equal terms.

I consider, however, that in order to insure that some work shall be at once undertaken in every parish or district within the area of supply under such Order, there should be a list of streets scheduled for compulsory laying of mains, and a deposit made in every case where the local authority may wish to have it.

Where there are two companies in the same area, different streets should be scheduled for each.

With regard to the clauses affecting supply, interference with streets, testing, position of stations and distributing boxes, and other details, the whole of the suggestions made by the local authorities should be carefully weighed, and those which are considered necessary embodied in the model form of Order.

With regard to price, I do not consider that any one district in the Metropolis should be put in a better position than another.

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Taking the area as a whole, it does not appear that it would be wise to fix a lower maximum than 8d. per unit.

It is true that the London Company is now supplying at 7½d., and the maximum in the St. James and Pall Mall Company's License is 7d., but these companies are competing in an exceptionally good area.

There would, however, appear to be a necessity for a reduction of the high rate for minimum supply—that is, the sum which every customer taking a supply can be call ed upon to pay, irrespective of the amount which he has consumed, and which in the Orders varies between £3. 6s. 8d. per quarter in the case of the Notting Hill Company, and £5. 10s. in the case of the Metropolitan Company's South London Order.

The latter Company has consented in the Mid-London and West London Orders to reduce the minimum to 13s. 4d. per quarter, and I consider that whatever minimum is fair should be adopted throughout.

The provision for revision of price after each seven years, in the agreements between the Metropolitan Company and the Strand and Marylebone local authorities, seems to me to be somewhat contrary to the policy of Parliament when dealing with the Electric Lighting Act. If any such provison be inserted it should be general, and it would appear to be more fair that the revision should take the form of a sliding scale upon the basis of a 10 per cent. dividend, the standard being fixed after the experience gained by the working of the first seven years.

It has been suggested that in the matter of price the consumer should, if he elects himself to pay the whole cost of connecting his house to the mains, have no minimum at all imposed upon him, but although I can see no objection to this proposal such a provision, would hardly be necessary where the minimum is reduced as in the Metropolitan Orders.

(3.) That in every case the supply of electricity, whether by a company or by a local authority, should be under statutory obligations as well as statutory powers by means of a Bill, a Provisional Order, or a License.

(4.) That there is no objection to the granting of a large area of supply to any company which shows that it has sufficient capital and is capable of coping with the demand. On the contrary, a large and rich company is likely to be the best and most economically managed concern, to be able by working over a large and scattered area to develop the demand for the light, and by rapidly increasing its business to be the sooner in a position to reduce the price of the article supplied.

(5.) That in the abstract competition is desirable, as tending to keep down the price, and to cause the manufacture and supply of electricity to be carried on with all the attention and energy which it is possible to devote to it.

The competition with gas, which at present at any rate, and probably for many years to come, will appeal to a totally different class of customer, will not be nearly so effective, while the potential competition from the power of calling in a new company in an area badly served is not likely to be called into play until the bad service has passed through many degrees, and has reached a very low ebb indeed.

The question as to how many companies should be granted concurrent powers in one area requires more consideration.

In cases where the local authority objects to the entrance of any company, and it is decided to overrule the objection, I think that one company only should be granted powers.

In cases where two or more companies have obtained the assent of the local authority, the following facts must not be lost sight of :—

1st. That the laying of the mains of several companies up one street means so much dead capital, and, moreover, the provision of a certain amount of useless material, which the local authority would have to pay for if it should decide to purchase the undertakings after the lapse of 42 years.

2nd. That, no matter what regulations or stipulations may be made as to the laying of mains, the interference with the streets, and the consequent inconvenience to the public, must be in a certain degree proportionate to the number of companies having powers over these streets.

For these reasons I am of opinion that, for the present, powers should not be given to more than two companies over the same area, and, inasmuch as the companies supplying under the alternating current and transformer system cannot supply electric energy capable of use for motors, that both these two companies should not be those using this system.

In order, therefore, to leave room for the entrance of a direct supply company into an area where two alternating current transformer companies have been assented to, it will be necessary to choose one only of these companies, and this will lead to a certain amount of districting.

(6.) That wherever a company now supplying a district by means of overhead wires is granted an Order for such area, it should be placed under the obligation to remove these overhead wires within a period of two years from the granting of the Order ; and, if such a thing be possible, that this company should be prevented from invading a district in which it has not got powers by means of overhead wires.

(7.) That in order to reduce as much as possible the disturbance of streets, clauses should be drafted making it obligatory for companies to lay their mains in existing subways, and to transfer them into subways which may be made in the future upon being called upon to do so.

If possible it would also be advisable to provide that, wherever circumstances admit of it, and where there is no subway, the conduits put down to lay the mains should be made capable of accommodating the mains of both companies in the area, if there be two companies having powers therein.

To a certain extent also it would appear to be right that the local authorities should have the power of objecting to the sites for generating, as distinguished from distributing stations, subject to an appeal to the Board of Trade.

Recommendations.

Applying these principles to the Orders asked for by the several companies, I recommend the Board of Trade to adopt the following course in each case.

I. *The London Electric Supply Corporation.*—As this Company and the Metropolitan Company are competing in many parishes and districts, and are both companies working with alternating currents, unable at the present time to provide for motive power, the areas applied for should be districted, and I propose, therefore, to allot to the London companies and to include in the London Order the following parishes and districts :—

The portion of St. Martin-in-the-Fields lying to the south of the Strand and west of St. Martin's-lane ; the portion of St. Margaret and St. John, Westminster, lying to the north of Victoria-street, excepting that portion of St. Margaret's lying to the west of St. George, Hanover-square ; St. James, Westminster ; St. George, Hanover-square ; Chelsea ; the Greenwich District ; St. Mary, Rotherhithe ; St. Mary, Bermondsey ; the District of St. Olave ; the District of St. Saviour, Christchurch ; and that portion of St. Mary, Lambeth, lying to the north of Westminster Bridge-road.

The only dissenting local authorities in the above areas are the Vestries of St. James, Westminster, of St. Mary, Lambeth, and of St. Margaret and St. John, Westminster, and the District Board of St. Saviour's ; but of these the first two would, judging from the statements of their representatives at the inquiry, consent, if their objections be, in the opinion of the Board of Trade, fairly met ; and it should be pointed out to them that while St. James' would under the terms of the Order gain by the compulsory removal of the overhead wires with which the London Company is at present largely supplying in the parish, it is in the case of St. Mary, Lambeth, essential to the continuity of the London Company's area that this company should have the means of passing through the northern end of the parish.

This last reason applies equally to the parishes of St. Margaret and St. John, and the opposition of the united Vestry of these parishes was not so strong as to lead to the belief that it would object to the division of the parishes as I propose between two companies, especially as there appears to be a demand for electricity in the district.

The district of St. Saviour's, after assenting to the granting of the Order, withdrew the assent, but did not appear at the inquiry to give any reasons for so doing, and as the district intervenes between other portions of the London area, the local authorities of which have assented and wish for the supply of electric light, I submit that the objection of St. Saviour should be overruled.

The case of St. James and St. John, Clerkenwell, is difficult to deal with. This parish is cut off from the district which I propose to allot to the London Company, and the Metropolitan Company has abandoned the North London Order, in which it was included, while the Vestry has assented to the entrance of both companies.

If the City should consent to allot a district to the London Company, giving access to Clerkenwell, this parish should be added to the London area, otherwise it might be suggested to the Metropolitan Company to adhere to their North London Order so far as this parish is concerned.

The general form of the clauses of the Order should be similar to those in the other Orders for the Metropolitan area, and it will be better to deal with all the suggestions and requirements of the local authorities on this head generally, when the principles upon which the Orders are to be granted have been considered and determined ; but there are two special clauses in the London Order, which have already been alluded to, and might be dealt with separately.

I do not see any objection to Clause 55, authorising the supply to a local authority of electricity in bulk, provided, in the opinion of the legal authorities, it be possible to place the local authorities under the obligations of the Order by any such clause.

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As to Clause 56, I think that, subject to the subdivision of the generating station at Deptford, as recommended on page 19 of this report, it would be a mistake to reduce the cubical dimensions of the building.

A compliance with the recommendations on the above-mentioned page should be a condition upon which the granting of the Order should depend.

II. *The Metropolitan Company.*—To this company I would recommend that the following area should be allotted :—

Under the Mid-London Order.—St. Giles-in-the-Fields; St. George, Bloomsbury; St. Andrew, Holborn above Bars; St. George the Martyr; St. Sepulchre, Saffron-hill; Hatton-garden, Ely Rents and Ely-place; the Liberty of Glasshouse-yard; St. Anne, Soho; St. Paul, Covent-garden; St. John the Baptist, Savoy; or precinct of Savoy; St. Mary-le-Strand; St. Clement Danes and the Liberty of the Rolls, together with the extra parochial places known as the Charter House, Gray's Inn, Lincoln's Inn, Staple Inn, and Furnival's Inn.

The whole of the local authorities in the above area assent to the Order.

Under the West London Order.—St. Marylebone, the Vestry of which assents to the Order.

Under the South London Order.—St. Mary, Lambeth; St. Leonard, Streatham; and Clapham.

Neither of the local authorities affected, viz., the Vestry of St. Mary, Lambeth, and the Wandsworth District Board, has signified its assent, but both would probably do so if their objections be met in a manner considered fair by the Board of Trade.

Under the Bill.—That portion of St. Martin-in-the-Fields which lies to the East of Northumberland-avenue, Charing-cross, and St. Martin's-lane.

The Vestry of St. Martin-in-the-Fields assents to the Bill.

With powers in this area the Metropolitan Company will have access from the main portion of the Strand District to the outlying portions, and will also have powers over some portion of the parish of St. Martin-in-the-Fields, contiguous to their existing station in Whitehall. In the latter portion, although the company will be competing with the London Company, there will not be two alternating-current companies, as the supply from the Whitehall station is by continuous current.

The only area in which there will be two competing alternating-current companies is in North Lambeth, where it cannot well be avoided.

III. *The House-to-House Company.*

IV. *The Notting Hill Company.*—I recommend that the areas as agreed to between these companies and the Vestry of Kensington be approved of, and the Orders granted in suitable terms.

V. *The Kensington and Knightsbridge Company.*—Similarly, in the case of this company, I recommend that the area as agreed to between the company and the Vestry of Kensington be approved of, and the Order granted.

With regard to the part of the parish of St. Margaret, Westminster, applied for, I recommend that the Order be approved of subject to the consent of the Vestry. This body has decided to object to the powers which are being exercised under Licenses granted by consent being extended to those given by Provisional Order, but I trust that the matter may be so represented that this decision may on reconsideration be altered.

VI. *The Chelsea Company. South Kensington Order.*—This Order is assented to by the Vestry of Kensington, and I recommend that it be granted for the area agreed to.

Belgravia Order.—In the case of this Order I see no valid reason for dispensing with the consent of the Vestry, which has been withheld. Consent has been given to the Orders of three other companies.

VII. *The Westminster Company.*—Although the scheme of this company is in a somewhat inchoate condition, the Vestry of St. George's, Hanover-square, has assented to the Order. The Vestry of St. Margaret and St. John, Westminster, withholds consent, but for reasons already given I consider that powers over part of the area asked for in this district should be given, the existing station of the company being in this area.

I recommend that the Order be granted for the parish of St. George, Hanover-square, and the portions of St. Margaret and St. John, Westminster, lying to the south of Victoria-street.

This company has abandoned the remainder of the area originally applied for.

VIII. *The Electrical Power Storage Company. Paddington Order.*—In view of the objection of the Vestry, and its expressed intention to undertake the lighting of the parish, and for other reasons given below, I cannot recommend that this Order be granted.

St. Martin's and Strand Order.—The Vestry of St. Martin's assents, and the Strand District Board dissents to the Order.

The company applying for these Orders is a company manufacturing batteries and other electrical appliances, and it seems more than doubtful whether, under the Articles of Association, there is any power to undertake the manufacture and supply of electricity for house-to-house lighting purposes. However this may be it is perfectly clear from the evidence of the manager of the company that the company does not intend to exercise the powers which would be granted by the Order, but to transfer them to some other persons.

I have no doubt that these persons are perfectly willing and competent to carry out the powers and obligations of the Order, but I submit that it would be quite contrary to practice to grant an Order to any but a properly constituted company, proved to be in a position to act under it, and as this has not been done I cannot recommend that the Order be granted.

It should be understood that in every case the recommendation to grant these Orders is on the understanding that the whole of the works, both at the generating and other stations, and along the mains, are to be planned and executed in a manner such as to satisfy the Board of Trade that the public are properly protected, both as regards safety, and, so far as may be possible, from any extinction of the light for an appreciable time, and that should it be found impracticable to carry out the districting between the London and Metropolitan Companies in the manner which I have proposed, the whole question will be reconsidered, so that the areas may be fairly readjusted.

The Metropolitan Orders for the Strand and Marylebone should be in as nearly as possible the same form as those applying to other parts of the Metropolis, as there does not appear to be any sufficient reason for treating these areas differently from any others.

The only districts applied for in which I have decided not to recommend the granting of Orders, as amended, are the parishes of St. Pancras and Paddington, where the local authorities should, I think, be granted time to decide definitely whether or not to carry out the lighting of their parishes under the powers of a Provisional Order; and the City, which, although not exempted from the operation of the Electric Lighting Acts, is in a somewhat different position from other parts of the Metropolis.

The Commissioners of Sewers, acting for the Corporation, are endeavouring to obtain tenders for the lighting of the City, but I see no reason why the principle that all such lighting should be done under statutory powers and obligations should be departed from in their case.

If the Board of Trade should agree in this view, I would urge the Commissioners of Sewers to consider whether the Orders as remodelled do not sufficiently provide for all their requirements, and in that case to consent to the division of the area of the City between the two competing companies, viz., the London and the Metropolitan Companies, the latter company being allotted the portion nearest to the Strand District, and the former the Central and Eastern portions of the City, so that access may be given to the Parish of Clerkenwell, the Vestry of which wishes for an Order to be granted to this company.

In addition to the above-mentioned Provisional Orders the two Licenses applied for by the Chelsea Company and the House-to-Company have to be considered.

These Licenses are both for areas included in the portions of the parish of Kensington allotted to the companies respectively by the Vestry, and the consent of the Vestry has been given.

Subject to any alterations in clauses which may be found necessary to make the provisions of these Licenses similar to those of the Provisional Orders applied for, I can recommend that, for the purpose of expediting the commencement of the works, they be granted.—I have the honour to be, Sir, your obedient servant,

F. A. MARINDIN, Major, R.E.

I concur with the above report.

P. CARDEW, Major, R.E.

The Secretary, Railway Department, &c., &c.,
Board of Trade.

The Secretary to the Board of Trade has forwarded the following letter to the Chairman of the London County Council :—

"Board of Trade (Railway Department),
"London, S.W., May 18, 1889.

"ELECTRIC LIGHTING ACTS, 1882 AND 1888.

"MY LORD: I am directed by the Board of Trade to transmit to you the enclosed copies of Major Marindin's report, made after his inquiry, held by direction of the Board of Trade, into the various applications for Provisional Orders and Licenses under the above-mentioned Acts in respect of the Metropolis, as well as into the subject-matter of a Bill introduced into the House of Commons by the Metropolitan Electric Supply Company (Limited).

"In forwarding copies of this Report for the consideration of the County Council I am to inform you that, subject to any observations that they may wish to offer, the Board of Trade propose to adopt the recommendations of the Report with regard to the allocation of the various districts to the several companies.

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"A description of these areas will be found in the Report, from which it will be seen that in the following districts only powers over the same area are proposed to be granted to more than one company, viz. :—St. George's, Hanover-square; a small portion of the parish of Lambeth, to the north of Westminster Bridge-road; a small portion of the parish of St. Martin-in-the-Fields, to the east of Northumberland-avenue and St. Martin's-lane.

"The Board of Trade concur in the opinion expressed by Major Marindin that, looking to the fact that the supply of electricity on the alternating-current and transformer system cannot be made use of for motors, the competition of a system which can be made useful for motors is desirable, and that, consequently, where powers are granted within the same area to two companies, both those companies should not be those using alternating currents. This principle has been adopted in allocating the various districts, except in so far as regards a small portion of the parish of Lambeth to the north of Westminster Bridge-road, which has been allotted to the London Corporation and the Metropolitan Company, both of which propose to use alternating-currents and transformers.

"The latter Company was the only one which proposed to take the whole of the parish, and they are in possession of a site for a generating station in the northern corner of the parish. The whole of the parish was, therefore, allotted to this Company, but it was found necessary also to grant powers to the London Company over a portion of the parish, in order to give access to the districts allotted to it on the other side of the Thames.

"A small portion of the parish of St. Martin-in-the-Fields has been allotted to the same two Companies. But in this instance the latter Company possess a generating station in Whitehall-place, from which the supply is by a continuous current.

"In two of the parishes allotted to the London Company—viz., Chelsea and St. James's, Westminster—powers to supply electricity have already been granted to other companies by Provisional Order and License, granted in the years 1886 and 1888 respectively. Both of these Companies, however, use continuous currents.

"In the present Orders it is proposed to substitute for the provisions as regards Schedule A and Schedule B, hitherto usually adopted, a provision that the undertakers should be bound at once to lay down mains in certain streets to be scheduled, and that they should be compelled to lay mains in any other streets in the area on requisition by owners or occupiers.

"With regard to the question of capital, I am to point out that, while the capital of the various companies would, doubtless, be wholly inadequate if the entire areas allotted to them required to be lighted at once, they possess, in the opinion of the Board of Trade, sufficient capital to provide for all the work they are likely to be called upon at present to perform.

"As regards the maximum price chargeable, the Board of Trade, in the absence of any evidence that such a price would be excessive, propose to adopt the maximum of 8d. per Board of Trade unit. They think, however, that a clause should be inserted providing for a revision of the terms of charge at the end of seven years from the date of the Order, and they propose that this clause shall be so drawn as to make it possible to adopt, as regards electrical lighting, the principle of the sliding scale of charge, which has been applied with advantage under the Gas Acts. It is impossible at present to foresee the initial price which it will, at the end of that period, be reasonable to prescribe; but, following the analogy of gas, and considering that the electric companies only have a certain tenure of 42 years, the Board of Trade are of opinion that a price arranged on the basis of a 10 per cent. dividend would not be unreasonable.

"With a view of saving time the Board of Trade are now going through all the objections raised to the clauses of the Orders, and are preparing a model Order, which, with the necessary variations for the varying circumstances of different districts, would be adopted for the whole of the applications, and that as soon as this model Order is in a sufficiently advanced stage a copy will be forwarded to the County Council.

"In conclusion, I am to state that as time is of the utmost importance the Board of Trade would be glad to be favoured with the observations of the London County Council at their earliest possible convenience.—I have the honour to be, my Lord, your Lordship's obedient servant,

"(Signed) "HENRY G. CALCRAFT.

"The Earl of Rosebery, London County Council, Spring-gardens."

LONDON DISTRICTS AT PRESENT NOT ALLOCATED.

In view of Major Marindin's report on the various electric lighting schemes which came under his consideration during the inquiry instituted by the Board of Trade last month, it may be interesting to note some of the chief London areas which have not yet been allocated.

Limehouse.	Highbury.	Wandsworth (part of).
Stepney.	Highgate.	Putney.
Hoxton.	Hampstead.	Wimbledon.
Stoke Newington.	Kilburn.	Camberwell.
Hackney.	West Kensington.	Peckham.
Kentish Town.	Hammersmith.	Dulwich.
Islington.	Fulham.	Blackheath.
Holloway.	Battersea.	

Madagascar.—The telegraph lines recently established in Madagascar have been almost entirely destroyed by floods.

PROF. ELIHU THOMSON'S OSCILLATING ELECTRIC METER.

Our New York correspondent writes as follows:—"Some months ago Prof. Elihu Thomson, as noted in your columns at the time, brought out an ingenious electric meter in which the indications were effected by the oscillations due to the transfer of a liquid from one bulb to another, by means of the evaporisation caused by a conductor heated by the current and passing through the liquid. Prof. Thomson devised some forms of this apparatus, and I believe that of the standard adopted by him

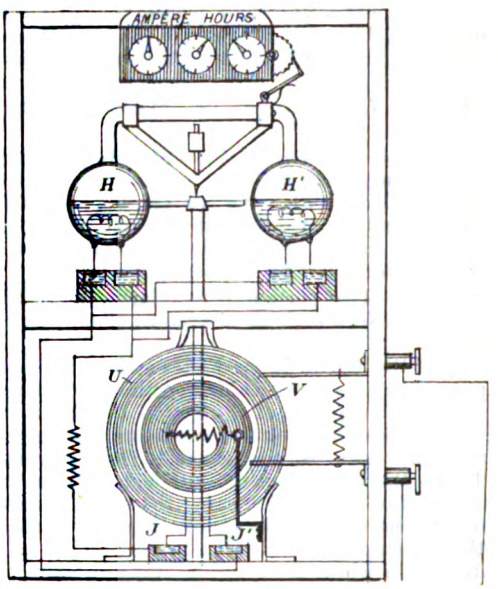

FIG. 1.—Prof. Elihu Thomson's New Oscillating Electric Meter.

several are now in use in various parts of the country on Thomson-Houston circuits with great success. Prof. Thomson has now introduced an interesting modification into the present form of this meter. It is obvious that in the first form described the effect is to produce a vibration which is as the square of the current in the coil, because the heat effect is as

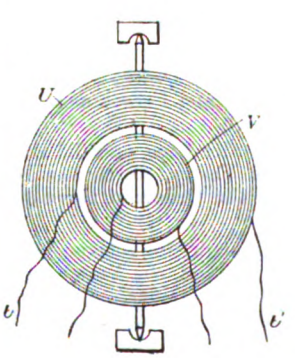

FIG. 2.

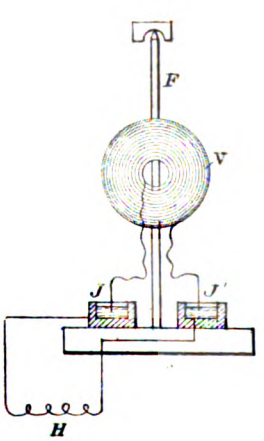

FIG. 3.

the square of the current, and is proportional to the time of flow. The effect principally desired, however, is one proportional not to the square of the current, but in the case of an electric meter directly to the current itself which is to be measured. It is to meet this point so as to produce a registry in direct proportion to the current flowing on the circuit that the new meter has been brought out. The correction is attained by passing currents through the meter in direct proportion to the square roots of the currents in the circuit of the lamps or motors, so that whether one lamp or a dozen are in

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use the record shall be true. One method of accomplishing this with a fair approximation in the case of alternating currents is to supply the meter from the secondary of a transformer whose primary connects with the circuit carrying current, the same as or proportional to the current to be measured, and to arrange the coils of the transformer so that their inductive relation may change through their mutual re-action or by other means so as to indicate the square roots of current passing. Prof. Thomson has also applied the method to the direct registration of continuous currents." The following description of the instrument appeared in a recent number of the *Electrical World* (New York):—

The general arrangement of this instrument is shown in Fig. 1, and Figs. 2, 3, 4 and 5 show a number of the details. As shown in Fig. 2, U is a fixed coil placed in the circuit with the lamps used by its terminals t t'. Mounted on a vertically-pivoted shaft, delicately poised, is a second coil, V, whose terminals are carried through J J' to the heating coils H or H' of the preceding Fig. 1. The coil V is, however, capable of rotation on its vertical axis F, Fig. 3, and to avoid friction its terminals dip in mercury cups J J', Figs. 3 and 4, from which cups connection is made. A delicate

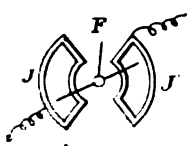

FIG. 4.

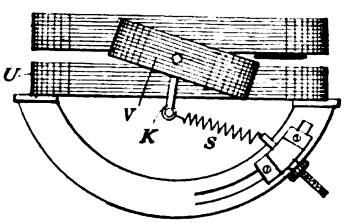

FIG. 5.

spring S, shown in Fig. 5, adjustable as to its fixed extremity both in position and elasticity, is attached to an arm K, extending as shown from the coil V or its supporting axis. The spring S is wound conically and is of very light wire, and is adjusted to pull in such direction, and its elastic force is made such that alternating currents in coils U will, when coil V is circuited through H, Fig. 3, cause deflection of V from the position shown in Fig. 5 to the position at which its plane approaches a right angle with that of coil U, and at the same time that the current induced in coil V by those in U shall be as the square roots of the currents in U. This condition is found to be attainable with tolerable approximation to accuracy by suitably proportioning the restraining influences governing the motion of the coil V under the deflective actions exerted.

The object is evidently to so adjust the parts and their relations of size and effect that the currents induced in coil V by currents in U shall always be in proportion to the square roots of the currents in U. If the coil V did not deflect, the currents in it would be in direct proportion to those in U. The deflection of V, however, causes the desired diminution.

Prof. Thomson has also applied the method to the direct registration of continuous currents. For this purpose a variable shunt V, Fig. 6, or other means of controlling the flow of current to the

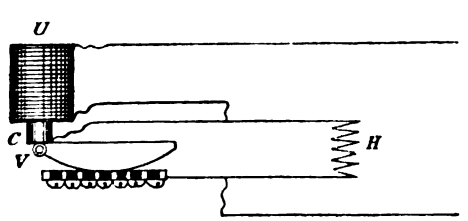

FIG. 6.

lamps, as, for instance, the heating-coil H, is employed. The variable shunt may be operated by a solenoid core C, or other device responsive to the flow of current in the circuit. The arrangement is so proportioned that increments of current in U will vary the shunt at V, or the resistance at V in shunt to H, in such way that H shall receive only the square roots of the current in the circuit. The variations are, however, not so smooth and delicate as they are with alternating currents in the arrangement above described.

A variable resistance, or resistance whose amount can be set or varied, may be added as a shunt around the coil U, as in Fig. 1, to standardise the readings of the meter. So arranged, the apparatus will register in proportion to the number of lights used and the time of use.

BOOKS, &c., RECEIVED.

"*Proceedings* of the Royal Society of Edinburgh." Vol. XV., No. 128, and Vol. XVI., No. 129.

"Electric Light for the Million." By Arthur Frederick Guy, A.I.E.E. (London: Simpkin, Marshall and Co.)

"A Dictionary of Explosives." By Major J. P. CUNDILL, R.A. (Chatham: W. and J. Mackay and Co.)

Report on the Mitchell Library, Glasgow. 1888.

"Journal of the Institution of Electrical Engineers." Vol. XVIII., No. 79. (London: E. and F. N. Spon.)

"Catalogue of Works on Shipbuilding and Engineering." (Berlin: W. H. Kühl.)

"Les Machines Dynamo-Électriques." By P. Clemenceau. (Paris: Bernard Tignol.)

Illustrated Catalogue. Bell's Asbestos Company (Limited).

The Second Edition of the Woodhouse and Rawson Electric Supply Company's Catalogue, List A.

Fourth Annual Export Catalogue of Machinery and Hardwares. 1888-9. (The Machinery and Hardware Company, Limited).

"Popular Handbook to the Crystal Palace and Outline of Arrangements for the Season of 1889." (Sydenham: The Crystal Palace Company.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, May 24th.

FINSBURY TECHNICAL COLLEGE.

7 p.m. Second Night of the Students' Conversazione.

INSTITUTION OF ELECTRICAL ENGINEERS.

9 p.m. Conversazione at the Royal Institute of Painters in Water-Colours.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "The Solar Surface during the Last Ten Years." By the Rev. S. J. PERRY, D.Sc., F.R.S.

SATURDAY, May 25th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "The Origin and Development of Opera in England (with Musical Illustrations)." By JOSEPH BENNETT.

PHYSICAL SOCIETY.

3 p.m. "On a Relation Existing Between the Density and Refractions of the Gaseous Elements and some of their Compounds." By the Rev. T. PELHAM DALE. "On a Water-spray Influence Machine." By GEORGE FULLER. Notes on Polarised Light:—(*a*) "On the Transition Tints of Various Orders." (*b*) "Lecture Illustrations of the Rotation of the Plane of Polarisation." (*c*) "On the Rotation of Circularly Polarised and Non-Polarised Light." By Prof. S. P. THOMPSON, D.Sc. "Terrestial Magnetism as modified by the Structure of the Earth's Crust." By Dr. EDMUND NAUMANN. "Molecular Weight of Caoutchouc and other Colloric Bodies." By Dr. J. H. GLADSTONE and Mr. W. HIBBERT.

MONDAY, May 27th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture VI., 4. "Heat Engines other than Steam." By H. GRAHAM HARRIS, M.I.C.E.

TUESDAY, May 28th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Some Recent Biological Discoveries." By Prof. E. RAY LANKESTER, M.A., F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Annual General Meeting. To consider the Report of the Council on the state of the Institution and to elect the Council and Officers for the ensuing year.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "The Westinghouse Alternating System of Central Station Electric Lighting in the United States of America." By JAMES S. HUMBIRD.

WEDNESDAY, May 29th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Science of Ventilation as applied to the Interior of Buildings." By D. G. HOEY.

THURSDAY, May 30th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Chemical Affinity." By Prof. DEWAR, M.A., F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Extraordinary General Meeting. Discussion on "Alternate Current Working." By W. M. MORDEY (Member).

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The Electrician.

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. Subscribers should receive their copies by the first post on Friday morning.*

"THE ELECTRICIAN" *is on sale at the railway bookstalls throughout the United Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices as above.*

SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

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For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
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Particulars relating to Advertisements will be promptly forwarded on application to the office.

TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xiii.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

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MAJOR MARINDIN'S REPORT.

Although Major MARINDIN has lost very little time in submitting to the Board of Trade his report upon the prolonged Inquiry into the London Provisional Orders, yet we think it will be very generally admitted that the report bears every mark of careful and intelligent consideration, and that in its general lines the policy therein laid down is probably as satisfactory and as practicable as any which could have been devised. Before referring to the other features of the report, which are common to the Orders as a whole, we may say a few words upon the allocation of areas adopted. As we ventured to surmise at the close of the Inquiry, Major MARINDIN has preferred to deal with the cases before him upon their individual merits, and he has not pronounced any sweeping verdict for or against the admission of more than one company into the same area. In the result, whilst there are several cases such as Kensington, where the parish is divided amongst two or more companies, there are but five instances (those of St. George's, Hanover-square; Chelsea (part of); St. James's, Westminster; a small portion of Lambeth, and a small portion of St. Martin-in-the-Fields) where two companies are granted concurrent powers over the same area. In these cases

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the general principle by which the Inspector has been guided is that one at least of the competing companies should provide a direct-current system, in order to obtain the convenience of working motors. Looking broadly at the results of its application, we have nothing to say against this principle; but it should be remembered that its significance is almost certainly merely of a temporary character. We shall, however, have an opportunity of witnessing the practical working both of direct competition and of the districting system under varying conditions and upon widely different scales.

It will be seen that, with the exception of the Electrical Power Storage Company, whose applications for Paddington and St. Martin's are both refused, and the Chelsea Company, who have lost their Belgravia Order, all the minor companies have been allotted the areas for which they have applied, although in certain cases they will have to compete either with the London or with the Metropolitan Companies. With regard to the division of territory between the two larger Companies, it appears to us that the London Company has received the lion's share, at least as regards extent of territory, while it has also obtained a footing into the coveted district immediately west of Charing-cross. The Metropolitan Company has obtained practically the whole of the West Central area for which it applied, but has lost the valuable districts of St. Margaret and St. John, Westminster, and St. George's, Hanover-square, in which quarters the London Company will be in direct competition with local direct-current stations. Further West, the Metropolitan has lost Paddington—which remains in the hands of the Vestry—but has retained the important district of Marylebone. In the South, it has lost St. Saviour's, but retains Lambeth, Clapham, and Streatham. The London Company loses Marylebone, Clerkenwell (provisionally), the Strand, St. Giles, and Holborn (all of which go to the Metropolitan), and St. Pancras (which remains unappropriated). It retains St. Martin's, the largest part of Westminster, St. George's, Hanover-square, Chelsea, Greenwich, Rotherhithe, Bermondsey, Lambeth (part of), and the Borough. The London Company will find themselves in competition with others in every part of their area except in the South-Eastern districts, from which we venture to surmise that the Inspector has been considerably impressed with the argument that the Ferranti system is of an exceptionally "experimental" character.

With regard to the City, Major MARINDIN sees no reason for departing from the principle applied to the rest of the Metropolitan area; and he urges the Commissioners of Sewers, who are acting for the Corporation, to consent to the division of the City area between the London and the Metropolitan Companies. An incidental objection to this proposal will probably arise from the fact that the Commissioners have already obtained tenders for the lighting of the City; and it is understood that the Anglo-American Brush Company, which has a certain claim to be considered in any such scheme, is one of the companies tendering. The Brush Company would thus be entirely shut out from the undertaking if Major MARINDIN's suggestion were adopted.

As regards the Vestries, they ought to be well content so far, for in one or two instances only have their objections been wholly or partially overruled. In the majority of cases, however, the opposition of the Vestry was confined to a few points of detail, and in these matters Major MARINDIN has wisely laid down the general principle that throughout the Metropolitan area the Provisional Orders shall all be drawn to a uniform model. The Board may therefore shortly be expected to issue a Model Order applicable to all companies and districts alike. It is a little unfortunate, however, that provision could not in some way have been made whereby the parties concerned would have had an opportunity of stating any objection to the terms of this Model Order before its final issue. At the recent Inquiry one company or Vestry may have objected to one clause and another to another, whereas a change in both clauses would possibly be objectionable to both parties. The matter is one of considerable importance, but it is difficult to see what remedy can now be provided unless the Board will consent to submit the Model Order for the consideration of the Chamber of Commerce.

Amongst the remaining proposals applicable to the Metropolis as a whole we may note the fixing of the maximum price at 8d. per unit, and the adoption of a sliding scale to come into force when the dividend reaches 10 per cent. It is, moreover, suggested that in the Model Order a clause should be inserted providing that at the end of seven years the question should be subject to revision by the Board. We may note, incidentally, that the Chelsea Company, under their Act of 1886, are entitled to charge 10d. per unit; this consideration probably had some weight with the Inspector when he decided to admit the London Company to their territory.

In a letter addressed to the Chairman of the London County Council, the BOARD of TRADE signifies its intention of adopting the recommendations of the Inspector as regards the allocation of districts, subject to any observations which the Council may wish to offer. The County Council, as is well known, has at present no actual jurisdiction in the matter, but its potential powers of interference are so considerable that expediency as well as courtesy probably dictated this frank recognition of the Council's right to be consulted. The Council will, we trust, have the good sense to perceive, however, that it will not be acting wisely if it interferes needlessly in matters with which the Board of Trade must be far more competent to deal.

RECALESCENCE OF IRON.*

BY DR. J. HOPKINSON, F.R.S.

Prof. Barrett has observed that if an iron wire be heated to a bright redness and then be allowed to cool, that this cooling does not go on continuously, but that after the wire has sunk to a very dull red it suddenly becomes brighter and then continues to cool down. He surmised that the temperature at which this occurs is the temperature at which the iron ceases to be magnetisable. In repeating Prof. Barrett's experiments I found no difficulty in obtaining the phenomenon with hard steel wire, but I failed to observe it in the case of soft iron wire or in the case of manganese steel wire. It appeared to be of interest to determine the actual temperature at which the phenomenon occurred and also the amount of heat which was liberated. Although other explanations of the phenomenon have been offered, there can never, I think, have been much doubt that it was due to the liberation of heat owing to some change in the material, and not due to any change in the conductivity or emissive power. My method of experiment was exceedingly simple. I took a cylinder of hard steel 6·3 centimetres long and 5·1 centimetres diameter, cut a groove in it, and wrapped in the groove a copper wire insulated with asbestos. The cylinder was wrapped in a large number of coverings of asbestos paper to retard its cooling; the whole was then heated to a bright redness in a gas furnace, was taken from the furnace and allowed to cool in the open air, the resistance of the copper wire being from time to time observed. The result is plotted in the accompanying curve, in which the ordinates are the logarithms of the increments of resistance above the resistance at the temperature of the room, and the abscissæ are the times. If the specific heat of the material were constant and the rate of loss of heat were proportional to the excess of temperature, the curve would be a straight line. It will be observed that below a certain point this is very nearly the case, but that there is a remarkable wave in the curve. The temperature was observed to be falling rapidly, then to be suddenly retarded, next to increase, then again to fall. The temperature reached in the first descent was 680°C. The temperature to which the iron subsequently ascends is 712°C. The temperature at which another sample of hard steel ceased to be magnetic, determined in the same way by the resistance of a copper coil, was found to be

* Paper read before the Royal Society, March 14, 1889.

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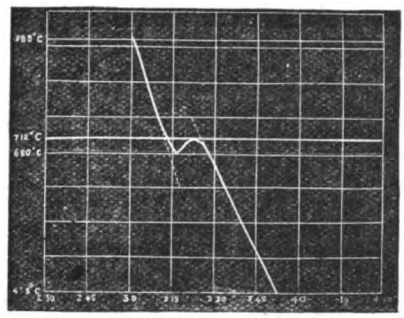
690°C. This shows that within the limits of errors of observation the temperature of recalescence is that at which the material ceases to be magnetic. This curve gives the material for determining the quantity of heat liberated. The dotted lines in the curve show the continuation of the first and second parts of the curve; the horizontal distance between these approximately represents the time during which the material was giving out heat without fall of



temperature. After the bend in the curve the temperature is falling at the rate of 0·21°C. per second. The distance between the two curves is 810 seconds. It follows that the heat liberated in recalescence of this sample is 173 times the heat liberated when the iron falls in temperature 1°C. With the same sample I have also observed an ascending curve of temperature. There is in this case no reduction of temperature at the point of recalescence, but there is a very substantial reduction in the rate at which the temperature rises.

ALTERNATE-CURRENT WORKING.*

BY W. M. MORDEY.

I wish to state at the commencement that this Paper is not intended as a contribution to the comparison of the relative merits of alternate-current working and of any system of direct-current supply. The discussion of this question has already taken place, and those who took the A.C. side have no reason to be dissatisfied with the result. It may, however, be pointed out that exclusive advocacy of any one particular method of working as being the best for all purposes is not a position that is likely to be taken by any electrical engineer who has any extensive acquaintance with the various requirements and conditions that are met with in practice.

Working Alternators Parallel, and Best Principles of Construction for Alternators.

This is a matter of very great scientific interest, and of still greater practical importance. It is not too much to say that the complete success of the transformer system of supply depends to a great extent upon whether alternators can be quite easily and successfully worked parallel. This has been strongly insisted upon, especially by the opponents of that system. The importance attached to it arises partly from the fact that the most economical method of supply is that of using always the smallest plant that will do the work, and increasing or decreasing the number of generating units in operation according to the fluctuations of the demand. To do this most conveniently, the alternators should be worked parallel, and ought to be capable of being put in and out of circuit easily, and without causing even a momentary flicker or interruption of the light. The use of a large machine and engine for the small day supply is especially to be avoided. In almost all cases it is desirable to have a comparatively small set of plant for this work, even where large machines are used for the heavy evening work.

Another argument in favour of parallel working, as against the use of very large machines, is that it reduces the cost of the spare plant. Thus, if a station is provided with one or two machines and engines for the full load, the spare plant is equal in cost to the working plant, or perhaps to one-half as much. If, however, smaller generating units are employed, one set in four may be considered a safe allowance.

The history of parallel working of alternators may be briefly sketched.

In 1868 Wilde described parallel working and synchronous action of generators, and so nearly obtained synchronous motor action that it is extraordinary he should have missed it.†

In 1882-3 Dr. Hopkinson,* not knowing of Wilde's work, arrived theoretically at the conclusion that it was possible to work alternators parallel, but not in series, and subsequently demonstrated the fact by trials made, in conjunction with Prof. Adams, on the De Meritens machines at the South Foreland Lighthouse, which were run parallel and as motors. This was all laid before this Society at the time, and was very fully discussed.†

In the course of this discussion in 1884, Mr. Alexander Siemens described some experiments showing that the Siemens alternate-current machine ran as a motor.‡ This is interesting as being, so far as I know, the only recorded instance of an alternator without iron in the armature being run as a motor. It will be remembered that the Wilde and De Meritens machines had iron cores. These experiments of Mr. Siemens were not very successful, the motor frequently stopping suddenly even when doing very little work; but they were of value for comparative purposes.

Passing over the next few years, we find that the use of alternators had become of great importance on account of the growth and development of the transformer method of distribution, and that there was and is a certain amount of doubt and hesitation about working parallel. It is recognised that it has been and can be accomplished, but that the arrangement is not one to be thoroughly and completely depended upon in every case. And there is sufficient justification for this doubtfulness. The present opinion may be fairly stated as follows:—Alternators may be successfully run in parallel if they have a good deal of self-induction, and to secure this it is better that they should have iron-cored armatures.

In his recent Paper on "Alternate-Current Machinery," before the Institute of Civil Engineers,§ Mr. Kapp dealt at considerable length with this part of the subject, and his views, I need not say, may be accepted as quite correctly representing the current state of knowledge and opinion. Referring to alternators that have self-induction negligible, Mr. Kapp says:—"Machines of this type can only be run in parallel if the strength of their field is adjusted with almost mathematical precision, and as this would require more skill and attention than is available with the ordinary staff of a central station, such machines are practically unfit for parallel working. To make them fit for this method of working, either the armature resistance or the self-induction must be increased. An increase of resistance, in order to be effective, would have to be so considerable as to seriously prejudice the electrical efficiency of the machine, and this expedient may therefore be dismissed as impracticable. The other plan of increasing the self-induction is not open to the same objection. It has the effect of lowering the plant efficiency, but its influence upon the electrical efficiency is only indirect, and so small that it may be neglected. From the foregoing, it will be readily seen that the only and sufficient condition for successful parallel working is a sensible amount of self-induction in the armature circuit. If the armature itself does not possess the quality in a sufficient degree, a choking coil of suitable self-induction must be inserted into the circuit of each machine. The results here arrived at, by a mere theoretical investigation, are entirely borne out in practice. It is well known that alternators having no iron in their armatures cannot be run in parallel, except by the adoption of some such expedient as choking coils; also that parallel running is feasible with those alternators which have iron-cored armatures, and then with different degrees of security."

Now this is a very serious state of affairs, for it really means, if true, that the only machines suitable for central station supply are those that, on account of their high self-induction and resistance, are bad regulators that will not bear any considerable change of load without varying a good deal in E.M.F., and that are wasteful on open circuit.

For my part, I have seen enough of the use of iron in armatures to wish to do without it if I can, and I have repeatedly pointed out that, if iron is really necessary, the armature is the very worst place to put it. For the purpose of increasing the self-induction it can be much better used outside of the machine, and put in some place where it is not subject to all the losses, restrictions, and disadvantages that necessarily accompany its employment in the core of an armature. If it is not in the armature it can be entirely removed when not required for the purpose for which it is thought to be necessary—that is, when only one machine is in use. To put iron in an armature merely to increase self-induction appears to show a want of common ingenuity and an absence of the sense of proportion.

But let us examine the evidence on this matter, in order to see what basis of fact there is for the present views.

In the first place, it will be found that the use of iron armatures is not in all cases to be relied on to give successful parallel working. In the discussion last year, Mr. Gordon, who has had very considerable experience, and who used iron largely in his machine,

* Paper read before the Institution of Electrical Engineers yesterday (Thursday) evening.

† On a Property of the Magneto-Electric Current to control and render Synchronous the Rotations of the Armatures of a number of Electro Magnetic Induction Machines.—H. Wilde, *Phil. Mag.*, Jan., 1869, pp. 54-62

* *Proceedings* of the Institute of Civil Engineers, 1882-3.

† *Journal*, XIII. (1884), pp. 496-559.

‡ *Journal*, XIII., p. 525.

§ *Proceedings* of the Institute of Civil Engineers, February, 1889.

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warned us in strong terms against working in parallel. He said :* "We know that experiments have been made by coupling a number of small alternate-current machines together, and at the South Foreland they were successful, but that was because they were working on arc lamps"—a little elucidation, perhaps, is necessary here. "Many of us have tried them, and they will, on trial, work together, no doubt, but they do not work together till they have run for three or four minutes; they will in that time jump, and that jumping will take months of life out of the 40,000 lamps. That alone is rather a serious difficulty in coupling machines together, and I think we may take it in practice—I am not speaking about the laboratory or experiments—we do not couple machines."

The Zipernowski alternator will, however, work parallel, but apparently not very well; to get it to do so the periodicity has had to be reduced to 42, as we now know.

Further, I have recently seen a communication from the highly experienced makers of a well-known alternator in which iron is used, stating that, if it is desired to run parallel, the machines, engines, and arrangements must be in every way identical; the impression conveyed being that with this machine the greatest care is necessary to ensure a successful result.

Then, again, the large experience of the Westinghouse Company in the United States has shown that their iron-cored alternators will work in parallel under some conditions. We are told that, with these machines, "parallel coupling always succeeds when they are loaded to about half their maximum output or over, but that machines working under a less load cannot with certainty be so coupled."

But the other day Prof. Forbes described† successful parallel working with the iron-cored Lowrie-Parker alternators at West Brompton, even with very light loads.

Thus it will be seen that we have evidence ranging from complete failure to complete success with iron-cored machines.

It is proved, then, that the presence of iron is not alone sufficient to ensure success, for the use of iron is associated equally with failure and with success.

That the success attained is complete only as regards the fact of synchronism is shown by the following extract from Prof. Forbes' remarks in the discussion on Mr. Kapp's Paper, which I quote at some length, because Prof. Forbes has taken every opportunity of ascertaining, by personal observation, what is being done, and because he gives us what is alone of much service at the present stage, viz., the independent record of actual facts, and tells us clearly what the real difficulties are.

The passage is‡ :—"The question of parallel working was one which had been very much discussed as to whether it was desirable or possible. . . . It was always possible, as Mr. Kapp said, with machines which had a very high self-induction—machines in which the armature had a great mass of iron in it. At the same time, the introduction of that self-induction into a machine reduced what Mr. Kapp called the plant-efficiency of the dynamo machine; and if they could work out, as he believed engineers would work out, some better means of making machines work in parallel, it would be very desirable. Another reason why the heavy self-induction was injurious was that it required such continued attention on the part of those in the station to see that the pressure was maintained constant. The electrical pressure varied so much that the quantity of current being developed, as shown by the table of curves, was seriously affected, and constant attention was required to keep such a machine regulated to the right pressure; whereas a machine which had no self-induction, or very little, gave off the same electric pressure, or nearly so, whatever the current might be, so long as the speed was maintained constant. As to the possibility of working conveniently in parallel with those machines, he might say that the experience of America had been completely against it. It was there found that it was possible to work in parallel, but that it enormously increased the amount of skilled attention required in a central station."

This is a very strong condemnation of the present system of obtaining synchronism, and at the end of his "Central Stations" Paper § Prof. Forbes returns to the subject in these words :—"I venture to think, however, that the plan now universally proposed for making machines work in parallel will not long be tolerated. This is to introduce into the machine a large amount of injurious self-induction, thus diminishing the plant efficiency, and rendering the equalising of pressure with various loads very difficult."

Turning now from alternators with to those without iron-cored armatures, we are brought face to face with the serious fact that, in spite of the many inconveniences connected with the use of very large machines, Mr. Ferranti is laying down the Deptford station to work with engines and alternators, each of several thousands of horse-power, and is depending upon the employment of spare engines and machines of corresponding size to prevent or to minimise the risk of wholesale extinction of the lights. It is understood that one of the principal reasons for doing this is that parallel working is not to be relied on.

The next question is, Is it clear that, in order to be able to run them parallel, or as synchronising motors (for I need not say that the two qualities are inseparable and are, in fact, identical), alternators should be bad regulators, should have large self-induction, or high resistance, or both? I think not. I have mentioned Mr. Gordon's machines, which certainly had the first of those qualities, but they would not run parallel. Other machines that I have referred to, and whose parallel working is not to be depended upon, are at any rate not remarkable for absence of self-induction.

Again, Is the absence of iron from the armature cores alone sufficient to deprive a machine of self-induction, and to give it a straight characteristic? I think not; for I have tested machines that had no iron, but that had a good deal of resistance, very considerable self-induction, that had very crooked characteristics, and yet that would not run parallel under any circumstances whatever.

So we see that neither a bent characteristic, nor self-induction, nor resistance, nor the use of iron cores, nor even the simultaneous possession of the whole of these admirable features and qualities—that none of these things is the secret of successful parallel working.

Perhaps—and this is a dreadful reflection—it is the exact opposite of all these!

Now I am in the unenviable position of being out of accord with the theories, the practice, the principles and the explanations of the very able men who have lately written, spoken, and worked on this subject. I have no doubt that all they have said is perfectly correct, so far as their difficulties are concerned—that they have experienced considerable trouble in working parallel, and have even in some cases met with actual failure. But this was partly because they have been unfortunate or unwise in the apparatus they have used, and partly because the principles that have been relied on to ensure success have not been in all respects suited to the case.

Although the conditions of the two problems are not in all points similar, I very respectfully submit that we are in danger of repeating the old mistake that was made regarding direct-current motors. We were taught that self-induction in the armatures was good, and that a special form and special proportions should be given to such motors; and I was very unorthodox when, in 1886,* I asserted that self-induction was not a virtue to be cultivated in motors any more than in dynamos, and generally that a good motor was a good dynamo, and *vice versâ*. However, it is some satisfaction to know that the views I then expressed have received the sanction of general practice, although I am afraid that in the eyes of Profs. Ayton and Perry those views remain as unorthodox as ever.

Now, I am prepared to take a precisely similar stand with regard to alternators, and to submit for your criticism the view that a perfect alternator for any and every purpose should have no resistance and no self-induction.

I prefer to regard the question of alternate-current parallel working as a question very largely depending upon what are the best principles of construction for synchronising alternate-current motors. It is very much better and simpler to look at it from this point of view than from any other, and I venture to assert, in spite of all that has been said to the contrary, that if alternators are made, amongst other things, with the least possible self-induction and the lowest practicable resistance, they will not only be the best alternators, but they will best run parallel, and will do so because they will then be the best synchronising motors.

I think that even the advocates of large self-induction will admit that that quality does not improve an alternator *per se*—they only introduce and tolerate it on account of its supposed bearing on parallel working (I could quote a number of such admissions); but it appears to me that, properly regarded, self-induction is not even a necessary evil—it is an unmitigated evil. It is an evil even for this narrow and restricted purpose.

What does it do? When machines are getting out of phase, it steps in and prevents that ready transfer of current which is required in order to check the leading machine and to accelerate the lagging machine. It prevents the latter from immediately and unhesitatingly developing those motor properties which lie at the root of successful synchronism. The foundation of parallel working should be that the prime motors are under the control of the generators. The question turns, therefore, partly on the qualities of the prime motor, but much more largely on the motor qualities of the alternators.

I am prepared to admit that if the tendency of the prime motor to lead or to lag is so great that under no circumstances can it be controlled—and this may arise either from excessive power on the part of a prime motor or from defect of motor power in an alternator—then large self-induction or resistance may be of use in order

* *Journal*, XVII., pp. 195-6, Feb., 1888.
† Board of Trade Inquiry, April, 1889.
‡ *Proceedings* of the Institute of Civil Engineers, Feb. 19, 1889.
§ *Journal*, XVIII., p. 195.

* *Phil. Mag.*, Jan., 1886, "The Dynamo as a Generator and as a Motor."

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to prevent one or more of the machines being burnt up, not, however, as useful and not as effective as a safety fuse; but self-induction under such circumstances is not an assistance to parallel working—quite the contrary. If it were absent, probably the machines would run parallel all right. They would be much less likely to be burnt up without self-induction than with it. Self-induction is useful because it prevents the machine which ought not to have it from being burnt up because it has it.

Now I will briefly describe some experiments with two of my alternators, each made for 2,000 volts, and each capable of working continuously at 35,000 to 40,000 watts, or, say, 50 E.H.P. output.

Arrangement.—Each machine was driven by a 75 indicated horse-power Fowler engine. These engines were similar, their normal speed of working being 120 revolutions per minute. Each of the engines, which were not coupled or connected in any way, was provided with a heavy fly-wheel, and drove, besides an alternator, a heavy and wasteful double (and in one case treble) set of counter-shafts provided with a large number of belts, fitted to an arrangement of fast-and-loose pulleys for convenience of testing all sorts and conditions of dynamos. I mention this as showing that the momentum in each case was very considerable.

In order to make the test as onerous as possible, the pulleys used were such that one engine had to run at 130 revolutions, while the other ran at 90 revolutions, when the alternators were at their normal speed of 650 revolutions per minute.

(1.) The alternators were run up to full speed, and each excited to give 2,000 volts. When in phase they were switched parallel without any external load, and without any impedance coils or resistance between them.

They ran parallel perfectly.

(2.) A considerable inductionless load was then put on, varied, and taken off. They ran equally well under all circumstances.

(3.) They were uncoupled, and then, the load being connected to the mains, they were suddenly and simultaneously switched parallel and on to the mains with perfect success.

(4.) One alternator was excited to give 1,000 volts, the other giving 2,000 volts. They were then switched parallel, and went into step perfectly, giving a terminal P.D. of about 1,500 volts. No impedance or resistance was used in this or in any other case. A load was then put on without affecting their behaviour.

(5.) With one machine at 1,000 volts and the other at 2,000 volts they were switched parallel *when out of phase*, and instantly went into step. A large current appeared to pass between them for a fraction of a second, but not nearly long enough to enable it to be measured or to do any harm.

(6.) They were then left running parallel while one was disconnected from the engine by its belt being shifted from the fast to the loose pulley. It continued to run as a motor synchronously. A load of lamps was at the same time on the circuit.

(7.) The two machines were then uncoupled and excited up to 2,000 volts. They were then switched parallel when out of phase and without any external load, and went into step instantly.

(8.) Whilst running as in (7), steam was suddenly and entirely shut off one engine. The alternators kept in step perfectly, one acting as a motor, and driving the large engine and all the heavy counter-shafting and belts. It was impossible to tell, except by the top of the belt becoming tight instead of the bottom, which machine was the motor.

To find the power exerted by the alternator acting as a motor (in 8), a direct-current motor was put in its place, and the power required to drive the engine and shafting was found to be 20 horse-power.

It may be pointed out that these tests were made under the most exacting and onerous conditions that could possibly be imposed, and particularly I would point out that on account of the very great momentum of the revolving masses nothing but the strongest and most instantaneous motor action could have kept the machines in phase. There never was a single case when they got out of step, even momentarily, or when subjected to sudden and violent variations of load. When it is considered that, in order to secure this result, it was imperative that the control of all that mass should be exerted in a fraction of $\frac{1}{200}$ of a second (the periodicity being 100), it will be recognised that there was no time to be lost, and that the use of any self-induction or resistance, or of anything else that could in any way choke, retard, check, or interfere with the strength and instantaneity of the action, was above all things to be avoided.

I should mention that the machines apparently synchronised equally well at speeds varying very considerably.

As to the self-induction of the machine itself, that is quite negligible. Its characteristic (Fig. 1) is nearly straight, about half the drop in the curve being due to resistance and half to self-induction.

Here was a machine generally allowed to be good when working singly, but possessing all the qualities that have been stated as unfitting it for parallel work, tested under all the conditions that are recognised as most trying, even for those types of alternators which are universally, and I believe erroneously, regarded as best suited for parallel work, and behaving throughout in a manner that simply left nothing to be desired, and carrying unimpaired into parallel work those features which it possesses when run singly.

I trust that I have now said enough to justify the views I have expressed.

A few particulars of this machine may be of interest. It now takes 500 watts to excite it at full load, and rather less than 400 watts on open circuit with full E.M.F. The efficiency when working with a light load is very high. The power required to run at full speed with full E.M.F. but no external load is 3 horse-power, of which 1·5 horse-power is ordinary mechanical loss in the bearings, &c., and 1·5 horse-power is electrical waste in the armature conductors and supports. This is from a most careful test, and shows that, so far as economy is concerned, with light loads the machine does not leave much to be desired. This is really of very great importance, for the expense connected with central station working during the long hours of daylight may be a serious item.

Alternate-Current Motors.

The bearing of the foregoing on the great and vital question of the construction of alternate-current motors is obvious. Much work has been done of late on this subject, and no doubt considerable success has been met with, but the use of alternators as simple synchronising motors has not appeared to attract much attention, probably because it is not known what excellent results may be obtained in this direction, and partly because of their inability to start from rest.

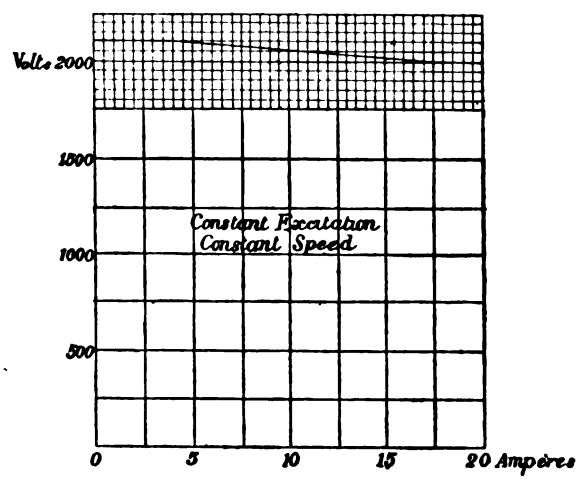

Fig. 1.—Characteristic.

The experiments just described, and others that I have carried out, showed what perfect self-governors such motors are. Not only do they maintain synchronism, but they possess an inherent economy which is most valuable. Just enough current passes through them to keep them in step and to do the work imposed on them. They become generators, and do work on the circuit, if from any cause there is a tendency for them to run faster than the generator.

I have devised a very simple means of starting such motors, which at a small expense removes the only drawback to their employment. The exciter, which is geared directly in some way with the alternator, is used, in conjunction with a small accumulator, as a direct-current motor to start the alternator. When synchronism is attained the latter is simply switched into circuit. It will be obvious that a small battery capable of a heavy discharge for a minute or two is all that is required. This is recharged by the exciter. I need not go into the details of the arrangements. This is perfectly practical. I should have no hesitation in running these alternators in regular work as motors, and should expect to find their "commercial efficiency" very nearly or quite 90 per cent.—about the same efficiency, whatever it is, that they possess as generators. For instance, the machines alluded to will work as motors at a useful output of 50 horse-power with this efficiency.

And here is another advantage in getting alternators economical when on open circuit. By doing so it becomes possible to use the very small exciter as a direct-current motor to get them up to the synchronising speed.

In many situations a synchronising A.C. motor will fulfil all requirements, and will do so with fewer drawbacks than any other kind of electric motor whatever. It will be a better regulator, more economical, less troublesome to look after, much safer to handle, and (what is of very great importance in connection with

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the transmission of large powers to a distance) the difficulty of dealing with high pressures, which is so serious with direct-current motors, is very easily overcome, for not only will alternators stand a higher tension in themselves, but, if necessary, transformers may be used to reduce the pressure between mains and motor.

(To be continued.)

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"On Lightning, Lightning Conductors, and Lightning Protectors."*

BY DR. OLIVER LODGE, F.R.S.

INSTRUCTIVE EXTRACTS FROM REPORTS OF DAMAGE BY LIGHTNING.

(Concluded from page 42, Vol. XXII.)

46. I may call attention to some apparently sound doctrines in a paper by Captain Bucknill, R.E., abstracted in *L.R.C.*, p. 242.

That lightning can penetrate into collieries is proved by an account of a meeting of Mining Engineers (*L.R.C.*, p. 237).

The same sort of thing is illustrated by the accident at Bootham Bar, York (*L.R.C.*, p. 219), when the lightning struck down into a cavity surrounded by high buildings with lead roofs, iron rain-water pipe, and an iron portcullis, to get at a street bracket 11ft. 6in. above the pavement, melting its pipe, and setting a house on fire by the large flame produced (*L.R.C.*, p. 219).

47. That the existence of gas-pipes make houses more difficult to protect, and in fact causes dwelling-houses to require almost as much attention as powder magazines, can be illustrated by a good number of extracts. The following may serve (*L.R.C.*, p. 239):—

"On July 13, 1880, during a thunderstorm, the large 400-light gas-meter of this mill, though locked up in a cellar, and with no light near it, exploded, and the gas, which is supplied through a four-inch main, was ignited. This was repaired, but on July 5, 1881, during another thunderstorm, precisely the same accident occurred."

From an interesting report, signed "J. Gavey," on damage to a church at Cardiff (*L.R.C.*, p. 218), I make the following extract:—

"On examining more closely the surroundings of the lightning conductor, I observed that the church gas-pipe, an iron one, about 1¼ in. in diameter, passed through the wall of the building about 6ft. from the conductor, and was carried in a direction corresponding with the hole caused by the explosion (see plan). I immediately concluded that this explosion was due to the current breaking across from the conductor to the gas-pipe, and on opening up the hole I found this to be the fact. The conductor crossed the gas-pipe at nearly a right angle, being about a foot above it. The under portion of the conductor bore evident marks of fusion, and, more interesting still, the gas-pipe was slightly coated with a very thin deposit of copper, so thin that it perished in my attempt to remove it; but still there was an undoubted coating at one spot."

Continuing the account of this kind of damage, the following interesting remarks by Prof. Kirchhoff have a bearing on the important practical question whether gas-pipes should or should not be utilised for earth; but their main utility lies in the proof afforded of the unique kind of danger which gas-pipes introduce:—

INJURY TO GAS AND WATER PIPES BY LIGHTNING.†

of Electrical Engineers, No. 77, Vol. XVIII., 1889, of Papers by Prof. W. Kohlrausch and Voller respectively.

The city gas company of Berlin having expressed the fear that gas-pipes may be injured by lightning passing down a rod that is connected with the pipes, Prof. Kirchhoff has published the following reply:—

"As the erection of lightning rods is older than the system of gas and water pipes as they now exist in nearly all large cities, we find scarcely anything in early literature in regard to connecting the earth end of lightning rods with these metallic pipes, and in modern times most manufacturers of lightning rods, when putting them up, pay no attention to pipes in or near the building that is to be protected." Kirchhoff is of the opinion, supported by the views of a series of professional authorities, that the frequent recent cases of injury from lightning to buildings that had been protected for years by their rods, are due to a neglect of these large masses of metal. The Nicolai Church, in Griefswald, has been frequently struck by lightning, but was protected from injury by its rods. In 1876, however, lightning struck the tower and set it on fire. A few weeks before the church had had gas-pipes put in it. No one seems to have thought that the new masses of metal which had been brought into the church could have any effect on the course of the lightning, otherwise the lightning-rods would have been connected with the gas-pipes, or the earth connection been prolonged to proximity with the pipe. A similar circumstance occurred in the Nicolai Church in Stralsund. The lightning destroyed the rod in many places, although it received several strokes in 1856, and conducted them safely to the earth. Here, too, the cause of injury was in the neglect of the gas-pipes, which were first laid in the neighbourhood of the church in 1856, shortly before the lightning struck it. The injury done to the school-house in Elmshorn, in 1876, and to the St. Lawrence Church, at Itzehoe, in 1877, both buildings being provided with rods, could have been avoided if the rods had been connected with the adjacent gas-pipes.

"If it were possible," says Kirchhoff, "to make the earth connection so large that the resistance which the electric current meets with when it leaves the metallic conducting surface of the rod to enter the moist earth, or earth water, would be zero, then it would be unnecessary to connect the rods with the gas and water pipes. We are not able, even at immense expense, to make the earth connections so large as to compete with the conducting power of metallic gas and water pipes, the total length of which is frequently many miles, and the surface in contact with the moist earth is thousands of square miles. Hence the electric current prefers for its discharge the extensive net of the system of pipes to that of the earth connection of the rods, and this alone is the cause of the lightning leaving its own conductor."

[This, like many another theoretical remark, is not to be supposed true.—O. J. L.]

Regarding the fear that gas and water pipes could be injured, he further says: "I know of no case where lightning has destroyed a gas or water pipe which was connected with the lightning-rod, but I do know cases already in which the pipes were destroyed by lightning because they were not connected with it. In May, 1809, lightning struck the rod on Count von Seefeld's castle, and sprang from it to a small water-pipe, which was about 80 metres from the end of the rod, and burst it. Another case happened in Basel, July 9, 1849. In a violent shower one stroke of lightning followed the rod on a house down into the earth, then jumped from it to a city water-pipe, a metre distant, made of cast iron. It destroyed several lengths of pipe which were packed at the joints with pitch and hemp. A third case, which was related to me by Prof. Helmholtz, occurred last year in Gratz. Then, too, the lightning left the rod and sprang over to the city gas-pipes; even a gas explosion is said to have resulted. In all three cases the rods were not connected with the pipes. If they had been connected the mechanical effect of lighting on the metallic pipes would have been null in the first and third cases, and in the second the damage would have been slight. If the water-pipes in Basel had been joined with lead instead of pitch no mechanical effect could have been produced. The mechanical effect of an electrical discharge is greatest where the electric fluid springs from one body to another. The wider this jump the more powerful is the mechanical effect. The electrical discharge of a thunder-cloud upon the point of a lightning-rod may melt or bend it, while the rod itself remains uninjured. If the conductor, however, is insufficient to receive and carry off the charge of electricity, it will leap from the conductor to another body. Where the lightning leaves the conductor, its mechanical effect is again exerted, so that the rod is torn, melted, or bent. So, too, is that spot of the body on which it leaps. In the examples above given it was a lead pipe in the first place, a gas-pipe in the last place, to which the lightning leaped when it left the rod, and which were destroyed. Such injuries to water and gas pipes near lightning rods must certainly be quite frequent. It would be desirable to bring them to light, so as to obtain proof that it is more advantageous, both for the rods and the building which it protects, as well as for the gas and water pipes, to have both intimately connected. Finally, I would mention two cases of lightning striking rods closely united with the gas and water pipes. The first happened in Düsseldorf, July 23, 1878, on the new Art Academy; the other August 19 last year, at Steglitz. In both cases the lightning rod, the buildings, and the pipes were uninjured."*

48. That lightning sometimes does things which is on the hitherto available views inexplicable is evidenced by the following record by one, who, of all others, made lightning conductors his hobby, who acquired an immense amount of experience concerning them, and to whom the carrying out of probably the most perfect system of protection in actual use is largely due. I mean the late M. Melsens:—

* Paper read before the Institution of Electrical Engineers on Thursday, April 25, 1889.

† See also on this subject two abstracts in *Journal* of The Institution.

* *Deutschen Bauzeitung.* (Quoted in the *Building News*, September 10 1880.)

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*Note on the Lightning Flash at Antwerp Railway Station, July 10th, 1865. By M. Melsens.**

"I have described this lightning stroke, which was very harmless, since all the damage was confined to the breaking of a square of glass in the roof of the covered station of the railway at Antwerp; but in connection with it I found myself confronted by so extraordinary a phenomenon that I had to search through all the descriptions of lightning strokes which might offer a certain analogy to this with which I have to do. It was only on looking through my notes again, and returning several times to the place, that I have ventured to describe this very extraordinary stroke, and I have only published it after a long time, when it seemed to me that I could establish it upon careful observations and experiments which seemed of a nature to corroborate my conclusions. [Mention made of 19 lightning flashes, which present some analogy to that which struck Antwerp Station.]

"A few words are sufficient to show the peculiarity of the phenomenon. The lightning crossed a square of glass and produced in it a hole similar to that which would be produced by a projectile thrown upwards from below at a slow rate, say, from 30 to 50 metres per second, and travelling from earth towards the sky; the edges of the hole were melted. I have given a description of the experiments I made, together with Ruhmkorff, to prove that in reality lightning does travel from the earth towards the sky; the proof which I give of it seems to me decisive.

"The extraordinary fact, as I have remarked, is to see the lightning pass, by means of a very bad conductor, through a square of glass 4 millimetres in thickness, forming a parallelogram of $0^{m}.35 \times 0^{m}.38$, having angles of 83° and 97°.

"The opening produced was at a distance of some centimetres from iron and lead conductors, which were in perfect metallic communication with all the iron of the station. The weight of this latter exceeds 120 tons. But the anomaly does not stop there; to the right and left of the glass roof in which the broken pane was, the covered platform of the station has a roof of zinc No. 13, presenting to the lightning a surface of 3,000 square yards; the weight of this zinc is not less than 15 tons; the three tall rods of the lightning conductor are in immediate metallic contact with this zinc and with the conductor, and the whole is connected to 28 hollow columns, serving to carry off rain-water. The collection of these metals would allow one to suppose that they were well adapted to carry off lightning or any such disturbance easily; but in this instance it despised them, and choose a path entirely unexpected. Let me add that there was a shed some 62 metres from the station built on hollow columns and iron framework, and the greater part of it roofed with zinc; moreover, about 40 metres on the opposite side were more sheds roofed with zinc; the metallic surface was not less than 2,000 square metres. Moreover, in my investigation, I might mention plenty of other metals in communication more or less perfect with the earth, grids, sconces, gas-pipes, telegraph wires, rails, &c. Besides, the whole of the platform may be considered as one large lightning conductor in perfect communication with a very damp earth, and offering hardly any resistance to the passage of the current from the building."

49. Of all the buildings in the world not wholly made of metal, the Hôtel de Ville at Brussels was and is the most perfectly and elaborately protected. No electrician exists but would a year ago have asserted, had he gone over it, that it was absurdly and exaggeratedly safe from damage by lightning. Last July it was struck and set on fire.

The case has been investigated and published in the *Bulletin de la Société Belge d'Electriciens* for September and October, 1888.

It seems to have been owing to secondary or induced electric surgings in a horizontal bar of metal totally disconnected from anything; not pretending to lead toward earth, and being some little distance below a stretch of lightning conductor not offering itself as an object to be struck. On all the old views it was utterly insignificant. However, as a matter of fact, although not struck, although it did not (probably) even receive a side flash, yet the induced surgings set up in it, induced by Maxwell and Heaviside's electro-magnetic waves, were so violent as to ignite some gas and cause a small fire. Had it been connected to the conductor, the sparking from it would probably have been still stronger.

This occurrence, and certain sparkings in the wall paper of the Royal Institution (see *The Electrician* or *Nature*, March, 1889), are plain and straightforward intimations that the old views on the subject of electric conduction are hopelessly and absurdly and dangerously inadequate. It is time that the prophets of that old superstition were slaughtered by the brook Kishon.

Practical Questions.

50. There remains to consider what is to be the practical outcome of all this—what improvements in the erection and testing of lightning conductors are possible. This is a matter well worthy of discussion, and eminently suited to it. It is a matter on which I have not the slightest wish to be dogmatic; and if I make a few apparently definite assertions it is only by way of expressing such judgment as I have able to form at present, and they are to be taken as intended more by way of suggestion and question than anything else.

With this proviso I should be disposed to make some such statements as the following:—

51. All parts of a lightning conductor, from points to roots, should be of one and the same metal, to avoid voltaic action.

52. Joints should be avoided when possible, and should be made substantially when necessary. Allowance for expansion and contraction must not be forgotten.

53. Sharp bends, and corners, and curves, and roundabout paths to earth should be avoided as far as possible.

54. The use of copper for lightning conductors is a needless extravagance.

55. Iron has advantages over every other metal.

56. The shape of cross-section is but little matter. Flat ribbon has a slight advantage over round rod, but not enough to override questions of convenience.

57. Liability to be deflagrated by a powerful flash determines the minimum allowance for size of cross-section. No consideration of conductivity and greater ease of path has the least weight in this connection.

58. It is hopeless to pretend to be able to make the lightning conductor so much the easiest path that all others are protected. All possible paths will share the discharge between them, and a lot of apparently impossible ones.

59. A good and deep earth should in general be provided, independent of water and gas mains.

60. If the conductor at any part of its course goes near water or gas mains it is best to connect it to them.

61. If the place to be protected has water or gas pipes inside it, the conductor should be connected to their mains underground.

62. At all places where water and gas pipes come near each other, and, in general, wherever one metal ramification approaches another, it is best to connect them metallically.

63. The neighbourhood of small-bore fusible gas-pipes and indoor gas-pipes in general should be avoided in erecting a lightning conductor.

64. Into powder magazines and such like places no gas or water pipes should be permitted to enter, unless the whole building is made of metal, and they are elaborately connected to it at the point where they enter.

65. It is not wise to erect very tall pointed rods above the roof of a building.

66. A number of points all along the ridge of a roof is better than only a few.

67. Any part of a building is liable to be struck, and, to make quite secure, every prominent part of the outside should have a rod running along it.

68. Insulated as well as earth-connected bodies are liable to spit off sparks.

69. No complete security can be attained unless the whole building be metal-lined, floor and all.

70. In ordinary houses it may be well to try and insulate the lightning conductor from the walls, so as to lessen the chance of side flash to metal stoves and things inside.

71. In chimneys it may be well to use insulators to protect the bricks from concussion.

72. The cheapest way of protecting an ordinary house is to run common galvanised iron telegraph wire up all the corners, along all the ridges and eaves, and over all the chimneys, taking them down to the earth in several places, and at each place burying a load of coke. Rain-water spouts and other outside metal, if all well connected together, may likewise be utilised.

73. Connecting a lead roof or other such expanse with a lightning conductor is not an unmixed good, for it virtually increases the dangerous proximity of the lightning conductor, and may inadvertently bring it near to many objects which else might have escaped.

74. One of the most difficult things is to know what to connect and what to avoid.

75. The orthodox rule, "Connect all pieces of metal to the lightning conductor," requires modification, thus:—Connect all pieces of metal to each other and to the earth, but not to the lightning conductor.

76. It may be always reckoned safe to earth things independently. It is often not safe to connect them to the lightning conductor, *e.g.*, an inside lining of a chimney should be well earthed, but should not be used as lightning conductor not connected with it. The same with rain-water pipes and gutters. The same also, probably, with lead roofs.

77. In connecting pieces of metal to each other, if they happen to form a nearly closed circuit the circuit should be metallically completed.

* "Paratonnerres Notes et Commentaires," par M. Melsens. Brussels, 1882. Extracted from reports of Belgian Delegates to the Paris Exhibition, 1881.

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78. Over the top of tall chimneys it is well to take a loop or arch of the lightning conductor, made of any stout and durable metal.

79. Lightning conductors should be always outside and easily visible.

80. A conductor detached from the building to be protected is safer than one in close contact with it.

81. For powder magazines and such like an outer cage surrounding the building, with sky points and earth roots, and an inner cage on the building, with independent earth terminals only, is the safest plan.

82. If under these circumstances there be no gas-pipes nor much ramifying metal work inside the building, and no metal at all going near either cage, the interior may be considered perfectly safe.

83. The inner cage may often be conveniently made of continuous sheet iron. The outer cage need not then be at all small-meshed; in fact, it need be little more than a dozen vertical conductors.

84. The resistance of an earth may be tested in the customary way to guard against actual breaches of contact by rust or workmen; but no overweening confidence must be felt, even though the resistance turn out the thousandth of an ohm or less.

85. A Wimshurst machine and couple of Leyden jars afford a convenient mode of testing a conductor for flagrant defects. The testing should be done in the dusk or in moonlight, so that there may be light enough to work by and yet sparks be visible.

86. Telephones are the handiest things to detect electric surgings in conductors inside the house while discharges are being made to the conductor. But vacuum tubes, gas leaks, Abel's fuses, &c., &c., can also be employed.

87. Another mode of testing can be carried out on an insulated rod, with an induction coil and spark gap after the manner of a great Hertz oscillator. This is probably the most searching plan. Sparks will then be probably obtained from all the gas brackets, water taps, and picture rails in the house.

88. Telegraph stations and houses supplied with electricity from overhead wires should have an efficient lightning protector at the place where the wires enter the house.

89. When a number of houses are wired up together for lighting, even by underground wires, it may be well to disconnect them by means of intervening lightning protectors on the principle of fireproof doors.

90. A central lighting station, having a tall chimney connected to its boilers and dynamos, should be, by a lightning protector, disconnected from the leads which carry the current from it, because a small fraction of a stroke getting into the leads might destroy a number of lamps, especially if they were already working at something like their full power.

91. Telephone arrangements, and any long length of close-packed insulated wires (even underground) should be protected by lightning protectors, else the insulation is apt to be sparked through and spoiled.

ABSTRACT OF DISCUSSION (AUTHORISED REPORT).

In opening the discussion Mr. PREECE said he did not wish to appear as antagonist of Dr. Lodge, but as a defender of the Lightning Rod Conference and the "older Electricians," and as an advocate of "Experience" as distinguished from "Theory." Those of the older school were guided by and had a great veneration for facts, whereas the deductions of theory were based on assumptions guided by mathematics, and were not always true.

Referring to case *a* (steady strain), he contended that no difference of opinion existed, and that this was the case taken up by the Conference. With regard to the relative merits of iron and copper for conductors, the Conference considered the question judicially, and recommended copper chiefly because of its greater durability. He himself always advocated iron, and considered a No. 4 galvanised wire amply sufficient for ordinary conductors. As a proof that self-induction was not ignored by the Conference a passage from the report was quoted, which states that the suddenness of lightning discharges affects the conductivity.

Coming to case *b* (impulsive rush), great difference of opinion exists. Though he had no doubt about the reality of the phenomena shown in Dr. Lodge's experiments by the aid of Wimshurst's machine, yet he contended that the deductions drawn from them were not necessarily true, that Leyden jar discharges were not comparable with lightning flashes, and that the tin plates used to represent clouds differed greatly in conductivity from clouds, which, on the authority of Dr. Lodge, are very imperfect conductors. He considered that the conditions of the experiments more nearly imitated a broken conductor, and mentioned that many similar experiments were made fifty years ago by Mr. Andrew Cross.

As regards the oscillatory character of discharges, all agreed that Dr. Lodge had shown that Leyden jar discharges could be made oscillatory by introduing self-induction, but he (Mr. Preece) thought there was no conclusive evidence that lightning flashes were so. On the contrary, telegraphic records of flashes made by Bain's chemical system, Thomson's recorder, and Wheatstone's receiver show no signs of oscillation. A recent case was described in which a Wheatstone receiver was kept running during a thunderstorm in Anglesea on Sunday, the 5th inst., and the resulting tape was exhibited. Further evidence of the unidirectional character of the current was said to be afforded by the signs of electrolysis exhibited by some conductors which had been broken by flashes. He had also examined wires fused by lightning in which the fusion appeared to have started in the interior, whereas according to Dr. Lodge the current is confined to the outer layers. This, the speaker submitted, tended to disprove the theoretical deductions, and he therefore thought that the fact of telegraphic instruments always being fused inside the coils pointed in the same direction.

Referring to lightning protectors in general use, experience proved that instead of such things being of the "most utterly imperfect kind," they were of immense service, for in the Navy no accident had been recorded since 1872, and in the Post Office Telegraphs not a single pole out of half a million had been damaged. In 1872, before the instruments were fitted with protectors, 19 per cent. of the instruments in use were damaged, but now the percentage is reduced to 1·3, and this he believes due to the non-protected instruments still in use.

Several conclusions of the Lightning Rod Conference had been severely criticised by Dr. Lodge in section 39 of his Paper, particularly those relating to the protection afforded by well-earthed conductors; and in reply to this criticism Mr. Preece said he was quite prepared to clasp a good conductor during a storm or even to sit on a barrel of gunpowder through which the conductor passed.

Mr. C. W. VINCENT, speaking of oscillations, said that he assisted Faraday in making experiments on the discharge of a large Leyden battery through various materials, but no signs of oscillation were noticed, although cases of intermittent discharge were frequently detected.

Mr. FARQUHARSON described a singular case of damage to H.M.S. "Coquette," in which part of the conductor passing from the mast to the copper sheathing of the vessel was torn away from the beam to which it had been attached. The only defect found in the conductor was a bad joint near the top, and he could never understand how this defect could cause the observed effect.

Mr. J. WIMSHURST considered that there was nothing very new in the impulsive rush, for he had been acquainted with it for some years. As regards the protection afforded by points against an impulsive rush, this depended greatly on whether the cloud was positively or negatively electrified. To show this a dome and point were placed on the lower of two insulated metal plates, and Leyden jars discharged into the upper. When the top plate was + the point was struck equally with the dome when both were at the same height, but when the electrification was reversed the point afforded a great protection. This difference is of consequence in Dr. Lodge's "bye-pass" experiments, and he (Mr. Wimshurst) had found that putting on the bye-pass reversed the direction of the spark across the air space.

Prof. W. G. ADAMS said that as chairman of the Lightning Rod Conference he thought the work done by that body had been misrepresented and unfairly criticised, for its objects were to examine and report on what was then known on the subject, and to condense existing knowledge so as to form a scientific basis for future practice, and these objects, he considered, were well carried out. He acknowledged that Leyden jar discharges produced remarkable effects then unthought of, but considered the statement that lightning flashes were strictly analogous unproved. As illustrating the truth of the older views the case of Brussels Town Hall was cited. This building, although elaborately protected on M. Melsen's system, has been recently struck, thus proving that the adverse opinion expressed by the Conference on the system adopted to be well founded. Another case in which the views of the Conference received confirmation occurred at the South Foreland Lighthouse in 1885. The flash struck the lantern, leaped to the electric lamp, passed through a long cable to the magneto machines, and thence by way of the engine-room conductor to a well 280ft. deep into which the conductor was earthed. The lighthouse conductor, where seen, was in perfect order, but the earth plate was found buried about 18in. below a gravel path resting on dry chalk. A man standing within a foot of the spark as it passed to the electric lamp felt no shock.

Prof. FITZGERALD, on rising, said he had said nearly all he had to say at Bath, but he wished to point out that the data now brought forward by Mr. Preece did not prove the non-existence of oscillations, for in all discharges—whether oscillatory or not—there is a definite flow in one direction which would produce the telegraphic records. Referring to Dr. Lodge's Paper, he said the weak point was the assumption that clouds behaved like good conductors, for it was well known that in horizontal directions they were very bad conductors. Of course it was possible that a shower might make them good conductors vertically; but this was a point on which no reliable data existed. Before Dr. Lodge's experiments the speaker said it would have been very difficult to account for the setting fire to the Hôtel de Ville at Brussels by sparks from an isolated bar of metal, and although the Lightning Rod Conference had done much good work, there were still many obscure points requiring experimental examination.

At this stage of the discussion Dr. LODGE (who is unable to attend the next meeting) briefly replied to some of the questions raised. With regard to Experience *v.* Theory, he considered that theory, guided by experiment, more likely to make progress than unguided experience. Owing to lack of theory Edison called into existence "etheric force" to explain phenomena of a character similar to those produced by electric surgings, and M. Mascart had observed similar phenomena, but had not described them because he could not understand them. Mr. Preece had said that no difference existed between them as regards case *a*, but this Dr. Lodge thought was not correct, for he maintained that surgings occur in case *a* as well as in case *b*; and he could not admit that when there was no oscillation there was no self-induction, for self-induction existed in every circuit.

Judging from Preece and Sivewright's telegraphy he concluded that lightning protectors frequently failed, and to be really efficient no single failure should occur.

Referring to Mr. Wimshurst's experiment, he said that he had not

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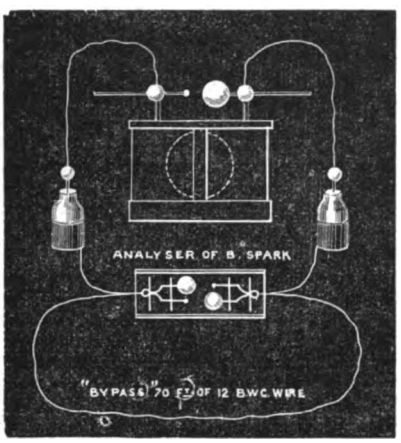
noticed any difference between the different protective effect of points with charges of opposite sign, for he never troubled himself about the matter of sign.

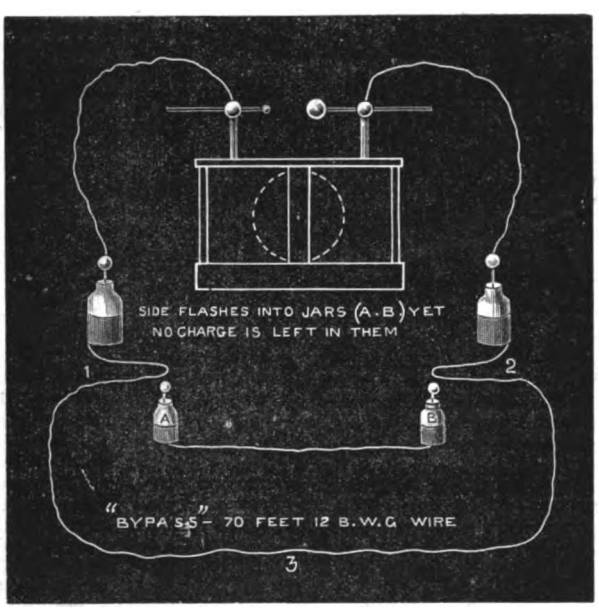
In conclusion, Dr. LODGE expressed his opinion that the Lightning Rod Conference did much good work, and regretted that he should have seemed antagonistic towards it.

The discussion was then adjourned to May 16.

THURSDAY, MAY 16TH.

Mr. WIMSHURST, on resuming the discussion, re performed his experiments on the difference in the protective power of points when the clouds are positive or negative, and said that in the latter case the point might be 2¼ to 2½ times as far away from the cloud as a dome and still protect. The reversal of the direction of the "B spark," by putting on a "bye pass," was also shown, together with experiments indicating that imperfect earth greatly increases the tendency to side-flash, and that this tendency is further increased by augmenting the size of the body receiving the flash and by connecting it to earth. In view of these facts the experimenter considered





The side flash at (1) is positive, and at (2) negative. At (3) the wire is normal, there being no side flash.—J. W.

[We are indebted to Mr. Wimshurst for kindly supplying us with diagrams, from which the above blocks were prepared. They are not in the authorised report.—ED. *E.*]

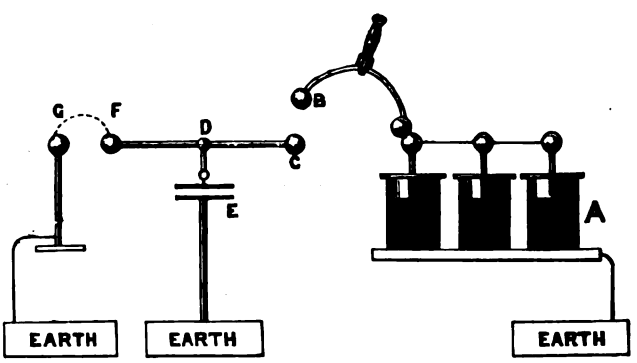
that the conclusions of Dr. Lodge, respecting the small importance of good earth and the propriety of connecting all pieces of metal together and to the earth, needed reconsideration. Side flashes were also taken by Leyden jars, and in some cases they were found unchanged when tested whilst in others the charge remained. An experiment, analogous to the sparking seen on the gilding of the walls during Dr. Lodge's experiments was next shown, in which sparks passed between separate pieces of foil forming a spangled outer coating of a Leyden jar when an insulated body within the jar was connected to an influence machine at work.

Prof. HUGHES said he did not agree with Dr. Lodge's statement that the "older electricians" never contemplated "case *b*," for Sir W. Snow Harris had recognised the difference, and from experiments made by Prof. Guillemin, M. Bertsch and himself, in an investigation on Lightning Protectors (see *Annales Telegraphique*, 1865, and *The Electrician*, July 13, 1888), it was concluded that Leyden jar discharges differed from ordinary lightning; for it was well known that protectors did protect instruments, whereas in their experiments with large jars nothing protected them. He also considered it unfair of Dr. Lodge to take all the credit of having recognised the distinction between cases *a* and *b* and the influence of self-induction to himself, altogether ignoring his predecessors in the field, for Prof. Guillemin showed that a sheet of tinfoil might protect an iron wire, whereas the same foil, rolled up like a wire, failed to protect.

As regards iron *v.* copper, his (Prof. Hughes') experiments prove that for rapidly-varying voltaic currents copper is decidedly superior, and the preference now given to copper for telegraphic and telephonic work points to the same conclusion. It had also been shown that iron wire was circularly magnetised by discharging a Leyden jar through it, and the production of this effect would, he considered, retard the discharge.

Mr. G. J. SYMONS thought Dr. Lodge did not realise the alarming nature of his own remarks in reference to the Rules of the Lightning Rod Conference; as a member of that body he was anxious to improve the rules wherever possible, but considered it injudicious to discard well-tried and safe rules until something better had been devised and tested by experience. As regards Points *v.* Knobs, the subject had been thrashed out 120 years ago. The Lightning Rod Conference had recognised the importance of hot-air currents, for they recommended that house conductors should be fixed to the kitchen chimneys. The dimensions of conductors was next referred to, and from the fact of large ones having been fused, the speaker thought Mr. Preece should not recommend small wire. He also stated that although the existence of a "protected area" around a conductor was disputed, yet much evidence pointed in that direction.

Col. ARMSTRONG, R.E., speaking of the protection of magazines, said he believed the War Office was the only body who had regular and systematic earth resistance tests made on their conductors. From his experience in the matter he could say that no accident had ever happened to a magazine whose conductors made good earth as shown by the regular tests, whereas several had occurred in cases where the earth was bad (say 200 ohms). In one case the conductor was fused below the point at which the main flash left the conductor, and this he believed due to want of continuity at the lower place. In another case cartridges packed in a sealed metal case were exploded by a lightning flash, thus showing that currents were not confined entirely to the outer layers, as Dr. Lodge supposes.



The above represents Prof. Hughes' original experiment of 1864, and is repeated from *The Electrician* of July 13, 1888.

Mr. A. J. I. ADAMS considered wires carrying varying currents to be under stress, and that such stress was relieved by radiation from the wire. The amount of this so-called radiation he takes to be a measure of the opposition offered to the passage of the current, and says that copper radiates about 25 per cent. less than iron or brass.

Mr. SPAGNOLETTI said telegraph wires were very seldom fused, although instruments were frequently damaged, and as an instance of such wires conveying large lightning currents, cited a case in which a lineman was killed by touching a wire which was struck by lightning at a point 50 miles away. He also asked whether lightning flashes had been proved to be oscillatory.

Mr. S. EVERSHED described some observations he made in 1877, which tend to show that the "B spark" does occur in nature. A thunderstorm was in progress about five miles from his place of observation, where he had a gold leaf electroscope and a quadrant electrometer connected to an insulated plate about 6ft. high. In the intervals between the flashes the leaves remained open about ¼in., but instantaneously with each flash they opened to three times that amount. The spot of light from his electrometer disappeared with such rapidity that he could never say in which direction it moved. These facts also show that "Nature" is not always "slow and solemn" as Mr. Preece would have us suppose, and the peculiar effects exhibited at Antwerp Railway Station prove that lightning does not always behave in accordance with the views of the Lightning Rod Conference.

Referring to Mr. Preece's supposed proofs from telegraphic records that flashes are not oscillatory, Mr. Evershed pointed out that such records would be produced even if oscillations were present, for a greater quantity of electricity passes in one direction than in the other.

The PRESIDENT (Sir W. Thomson), in closing the discussion, thought Dr. Lodge's Paper a most interesting and valuable one, and the Institution was greatly indebted to its author for bringing the matter so prominently forward. All admit that the importance of self-induction was not sufficiently recognised previously. He could not say whether Franklin knew of its existence, but Sir W. Snow Harris did, and many views held by the latter which until recently were condemned, have now been proved correct. Referring to § 56 in the Paper he thought Dr. Lodge did not mean what was

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there stated as to the shape of section of the conductor, for it was quite certain that flat ribbon had much less self-induction than round rod.

As regards gas and water pipes as earth, Sir William considered that they made a good earth, and he did not see much danger in connecting pieces of metal with the lightning conductor in cases where no other earth could be obtained.

In view of Col. Armstrong's statement about cartridges being exploded when completely enclosed in metal casings, he thought it important to try if iron cases afforded more protection than brass or copper ones, for it was probable that the magnetisation of the iron by the currents would produce additional screening. Faraday's electric cage experiment should also be repeated, using the more sensitive apparatus since devised to search for any internal effect.

In conclusion, the President said the Report of the Lightning Rod Conference is a very important work, and though some flaws may exist, yet on the whole experience gives very strong reasons for believing that the rules are good.

BOROUGH OF BEDFORD.

REPORT OF THE ELECTRIC LIGHT COMMITTEE.

This Committee was appointed by the Council on November, 9th, 1888, to consider and report to the Council upon electric lighting. . . .

After some preliminary remarks with regard to the advantages of the electric light, and the success achieved at Taunton (which town was visited by the Committee), the report proceeds as follows :—

Applications have been received from the following companies to light this borough with electricity, viz. :—

The Bedford Electric Light Company (Limited),

The Anglo-American Brush Electric Light Corporation (Limited),

The India-rubber, Gutta Percha and Telegraph Works Company (Limited).

The Committee has no doubt that any of the companies named would perform the lighting effectually, but it is obvious that if a company can make a profit for its shareholders such profit can be secured to the ratepayers by the Corporation supplying the lighting at the prime cost. The Committee therefore recommends that the Corporation should retain the undertaking in its own hands.

In order that the Council might be in a position to form an opinion of the feasibility of establishing an installation with profit, the Committee has given considerable care to the question of carrying it out practically, and as the result has to offer the following observations :—

As to the motive power proposed to be employed, the Committee in the first instance directed its attention to the use of the water-power of the river. The Committee finds that this is altogether inadequate to meet all the requirements of the Borough, and therefore does not recommend its use.

The Committee having carefully considered the question of a site of the proposed works, is unanimously of opinion that a portion of the land belonging to the Corporation on the west side of the Cauldwell Bridge could be most advantageously used for the purpose. It offers the following advantages :—

From a station there erected both sides of the Borough could be conveniently served. As it adjoins the river the water supply would be convenient and cheap, and, if necessary, a siding to the railway could be connected for the purpose of the delivery of coal.

It is also a sufficient distance from any property likely to be annoyed by the carrying on of the business.

The Committee submit the following detailed capital and annual expenditure accounts, which are based upon reliable information from existing successful companies :—

Capital Account.

Building, including chimney shaft	£1,500
Three engines of 75 horse-power each, including boilers	4,500
Four dynamos	1,000
One hundred arc lamps, £20 each	2,000
Wire (7 miles)	434
Labour setting up	500
Two dynamos for incandescent lighting	1,800
Two engines and boilers	2,250
Miscellaneous plant, sundry expenses	1,016
	£15,000

Annual Expenditure Account.

Interest on £15,000 at 4 per cent.	£600
Coal	800
Depreciation	375
Carbon renewals	330
Labour and electrician	450
Rent, rates, taxes, and other sundry expenses	200
	£2,755

The capital mentioned would be sufficient to provide an installation of 100 arc lights, and leave sufficient power to supply 4,500 incandescent lamps for private lighting.

The Committee has prepared and marked upon the map the suggested position of the public lamps. The lamps will be of 1,200 candle-power each.

For the purpose of these calculations the Committee has worked out the interest to be paid on the capital at 4 per cent., though there is little doubt that the money can be obtained at a lower rate.

In accordance with the foregoing account the annual expenditure will be £2,755

Estimated to be received from—

Incandescent lamps, 4,500 at 10s. each	£2,250	
Do. from churches, chapels, &c.	200	
		2,450
Net cost of lighting with electricity the area described		£305

The last two half-yearly payments for lighting with gas amount to £1,437. This amount is considerably increased every year, but it is taken for the purposes of comparison.

By the adoption of 100 electric lamps in the positions indicated 228 gas lamps would be displaced, the cost of which per annum is as follows :—

	£	s.	d.
Special lamps	93	17	0
Ordinary lamps at £2. 6s. 3d.	504	2	6
Police lamps extra	51	10	0
Representing an annual cost of	£649	9	6

The following figures will afford a comparative estimate of the relative lighting power of the two systems :—

100 electric lamps proposed to be introduced	= 120,000 candles.
228 gas lamps proposed to be displaced	= 4,000 candles.
Gain in lighting power	116,000 candles.

By the adoption of the electric light there will also be an immediate clear gain to the borough of about £345 per annum.

The committee has been most careful to place a moderate estimate upon the receipts for private lighting. It is quite certain that this profitable part of the business could be extended without any considerable increase of capital, and to such an extent that the Corporation may with confidence look forward to the public lighting being provided free of cost to the ratepayers. The committee confidently expects that the whole of the incandescent lights estimated for would be taken up as soon as they could be supplied, tradesmen especially being anxious to have the advantage of the light, both to avoid the damage now done to their goods by gas, and for other obvious reasons.

The committee recommends that it be empowered to take such steps as may be advised to obtain powers under the Electric Lighting Acts, and also to employ an electrician to advise as to the establishment of the proposed installation.

DETERMINING THE STRENGTH OF LIQUIDS BY MEANS OF THE VOLTAIC BALANCE.*

BY DR. G. GORE, F.R.S.

This method is based upon the circumstance that the greater the degree of concentration of a solution the larger is the amount of dilution required to reduce its voltaic energy to a given magnitude.

In a research on the "Relative Amounts of Voltaic Energy of Electrolytes"† (Roy. Soc. *Proc.*, Vol. XLV., p, 268), I have described the method of measuring the voltaic energy of a substance, and have given the magnitudes of such energy excited in a voltaic couple of unamalgamated zinc and platinum, by upwards of one hundred different substances when dissolved in water, in relation to that excited in the same couple by water alone, all the liquids being at atmospheric temperature.

In the present research, as examples of the applicability of the voltaic balance to determine the degree of concentration of liquids, I have taken aqueous solutions of nitric acid, hydrochloric acid, sulphuric acid, common salt, ammonia, and carbonate of soda, and ascertained the degree of strength of each by chemical analysis, by specific gravity, and by the voltaic balance method. The following numbers represent the proportions of water which were required by one part by weight of each of these substances in order to reduce its voltaic energy to the same magnitude, viz., to that required to just visibly move the needles of the galvanometer, and they therefore also represent the relative magnitudes of voltaic energy of the substances indicated by the respective formulæ.

						Temperature.	Average energy.
HCl.	Between	9,300,000	and	9,388,185	at	16·5°C.	9,344,092
H^2SO^4.	,,	3,690,476	,,	4,111,446	,,	19· ,,	3,900,941
HNO^3.	,,	3,039,215	,,	3,369,565	,,	19· ,,	3,204,395
NaCl.	,,	190,570	,,	221,428	,,	15· ,,	207,589
Na^2CO^3.	,,	−14,090	,,	−15,550	,,	19· ,,	−14,795
H^3N.	,,	−281,818	,,	−313,765	,,	15· ,,	−297,791

In each example given a known volume of solution was taken, and the proportion of substance in it was found by ordinary chemical analysis. A second portion was taken, its specific gravity ascertained by the method of weighing, and its degree of strength found by aid of the ordinary published tables of specific gravity. A third

* Read before the Royal Society, May 9, 1889.

† See also *Electrician*, April, 5, 1889, p. 626.

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portion of known volume was then taken, its average amount of voltaic energy measured, and its degree of concentration found by the amount of dilution required to reduce its energy to the same magnitude; the less dilute it was at starting the greater the amount of dilution required. The following are the results :—

By	HCl.	H^2SO^4.	HNO^3.	NaCl.	Na^2CO^3.	H^3N.
Chemical analysis .	1·85	5·60	2·97	9·13	7·21	1·05
Specific gravity ...	1·70	5·44	2·80	8·74	7·63	1·03
Voltaic balance ...	1·65	5·70	2·90	8·71	7·57	1·06

The variations in the numbers are partly due to inequalities of temperature.

A much less quantity of substance is usually required by the voltaic balance method than by either of the others, and the operation is very quickly performed.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May* 11, 1889.

One of the most important electrical events of recent occurrence in this country is the action taken by the Boston Board of Aldermen in granting unanimous consent to the application of the West-End Railway Company, for power to establish and maintain a single trolley overhead system on each and all of the streets, squares and thoroughfares in the City of Boston, where it is already operating. This is a momentous decision, for it simply means that if the plans of the company are carried out in their entirety Boston will have at least 300 or 400 miles of electric railway service using overhead conductors. As I have already noted in this correspondence, the Board of Aldermen as well as the State authorities have been investigating the subject for some time past. While the success of the conduit system put down in Boston has not been, it is claimed, very great so far, the Sprague and Thomson-Houston overhead systems have been running with most creditable regularity and efficiency. It is asserted that it has not been particularly the desire of the West-End people to make a brilliant success of their conduit system, for the reason that they prefer to operate by the overhead method, and did not wish to have the practicability of the conduit system or the storage battery system urged against them.

With reference to electric railway operation, it is interesting to cite the figures of the Cambridge division of the West-end Street Railway operated by Thomson-Houston motors with overhead trolley connection. It appears that during the month of April eight motor cars ran 17,680 miles, and the cars they towed 19,149 miles. The number of round trips of motor cars was 2,720, and but seven trips were lost. This is an improvement even over the previous record, when the cars lost but nine trips out of 1,179. The service is very popular with the people, and the cars are crowded.

It may be noted, while on this subject, that there is now a great deal of agitation in various places where electric railways are going in on the point whether the overhead wires shall be single, using the rail as a return circuit, or whether the companies shall be compelled to put in complete metallic circuits involving the use of double trolleys. The electric railway companies naturally prefer the single trolley system, on account of its simplicity and greater cheapness, but in several places the telephone people have conducted an active warfare against the single trolley, urging that the rail return seriously affects the efficiency of telephonic communication. On the one hand the telephone companies urge that the street railways ought to have complete metallic circuits, and on the other hand the street railway people urge that the telephones all ought to have metallic circuits. While no decisive settlement of this dispute is to be expected, we shall very likely see the provision insisted on here and there that the complete overhead metallic return shall be used on the new roads. It is worthy of note, however, that this has not been insisted on as one of the conditions in Boston, but I expect we shall hear of considerable opposition in that city from property owners and others, who imagine themselves to be injuriously affected.

Recently, at the meeting of the Beacon Society in Boston, the subject of electrical development was discussed, more particularly as related to electric light and power. One of the speakers of the evening was Mr. C. A. Coffin, the Vice-President and mainspring of the huge Thomson-Houston Company, In the course of his remarks Mr. Coffin said that during the last seven years the Thomson-Houston Company had organised nearly 500 local electric light and power companies, and that less than one per cent. had got into any financial embarrassment, while not one in the 500 had failed to pay its obligations in full. Moreover, the growth of these companies in the use of arc lights showed an increase of from 1,500 lights six years ago to between 50,000 and 60,000 at the present time. It may be that here in America we are given to exaggeration and "high falutin," but I take it that it is simply impossible to exaggerate the importance and significance of such a wonderful growth as this. At the Electrical Exhibition in Philadelphia, in 1884, the Thomson-Houston system was first practically introduced to the public notice in a striking way, but its two great rivals, the Brush and the United States Companies were already in possession of large portions of the field, and had vigorous subcompanies in operation all over the country. Hence the work of developing the new system was doubly difficult, and yet, as we have seen, the excellent apparatus and the skilful management were equal to a development like that above referred to, of his share in which Mr. Coffin spoke so quietly and modestly. Mr. Coffin made the statement that the Thomson-Houston system was being extensively introduced into Japan, and that his company were doing business in Europe, in South America, in Australia, Australasia, Canada, the West Indies, and other parts of the globe. He went on to remark that there are in Massachusetts to-day more electric light plants than in the whole of Europe. He found Italy to stand at the head of European nations, while in England, owing to the fact that so many gas works are owned by the town and the city authorities, the process of introducing the electric light is extremely slow, and attended with many difficulties. It was natural that Mr. Coffin should make reference to the work that his company is now doing in the matter of electric railways. He said they had found as the result of all their work—and they had already had a great deal of experience—that the cost of electricity does not exceed 60 per cent. of the cost of animal power, while on all the roads where electricity has been adopted there is a marked increase of traffic and patronage. One of the roads recently started, for example, shows receipts four times as great with four electric cars as they were with five cars run by horses. Mr. Coffin's statements as to electric lighting and electric railways were well supplemented by those given by Mr. Jenks, who spoke for the Edison system, and who said that the Edison Company now had in this country 200 stations and 1,525 isolated plants, with a total dynamo capacity of 1,126,000 lamps, which, of course, is far short of representing the number of lamps actually wired up to be run on those plants.

An invitation has recently reached this city from the Board of Trade of St. John, New Brunswick, with regard to the Exhibition which is to held there in the coming July. The Exhibition is planned in connection with the carnival celebrating the union of the cities of St. John and Portland and their looping into the system of the Canadian Pacific Railway. It is proposed to make the Exhibition largely electrical, and it is hoped and believed that the American manufacturers will be well represented. There is a fair quantity of American electrical apparatus now sold in that part of the Dominion, but it is believed that the full extent of the market has not yet been anything like realised. Of course, if there were reciprocity of trade between the two countries there would be no difficulty in doing a very large business; but even as things are now not a few opportunities present themselves. I do not know whether English manufacturers and concerns have been invited, but it is not to be lost sight of that the North American Colonies are naturally our customers for a large part of their electrical apparatus. I believe Montreal is the centre of what electrical manufacturing there is in Canada, but, as far as I can learn

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the output is not very large, and hence the cost of production remains high.

I noted the fact not long since that the Thomson-Houston people, at their Lynn factory, had been treating their motors to baths of cold water, and had found that as now constructed they would stand any amount of exposure and rough usage of that kind. Mr. S. D. Greene, of the Sprague Company, now comes out with a letter in the papers giving details of some very interesting experiments of like nature, but of earlier date, made at the Sprague Factory. An armature after having been treated in some method devised by Mr. Sprague was allowed to soak in a barrel of fresh water for 24 hours. It was then soaked for another 24 hours in a barrel containing a strong saline solution. It was next taken out and put into a machine and run for two and a-half hours on an overload of $33\frac{1}{3}$ per cent. At the end of this run the motor was tested and was found to be as sound as it was when the experiments began. It may seem to English electrical engineers that these little tests are perhaps mere showy *tours de force*, but those who are familiar with the conditions that often obtain on the American street railways well know that very often, especially in new communities or in growing suburbs, roads are none too well constructed, and hence the motors under the cars are exposed to serious danger from the seas of mud and dirty water through which they have to pass. I have myself been out on electric cars running for well nigh a mile together on tracks that were out of sight under the chilly and dirty accumulations of a spring thaw, where the snow had been two or three feet deep, and where the road bed had consisted of little but a made soil.

Another step has been taken in the direction of carrying out the New York State law for the infliction of the death penalty by means of electricity. Mr. Harold P. Brown, who has been so prominent in connection with all the experiments on the lower animals with the alternating current, has now made arrangements with the Superintendent of State Prisons to furnish him with three Westinghouse alternating machines, each having an E.M.F., it is said, of 1,000 volts. It would appear that Mr. Brown has secured this apparatus through some third party, so that the Westinghouse Company did not know the purpose for which it was to be used, and very sharp comments are made in some quarters on the necessity of resorting to such a subterfuge. It is said that the current will be passed through the victim by means of an electric cap made of metal covered with sponge, which will go on his head, and by a heavy pair of tightly-laced shoes with sponge inside which will go on his feet. After the electroded convict has been strapped into an open chair and fitted with his electrical cap and electrical shoes, the warden of the prison closes the circuit, and he is "electrosized" or "thanatopsied," or "electrocuted," or "electrogerried" in about 15 seconds. It was expected that all the electrical executions would have been carried out at one place to avoid mishaps, trouble and expense, but it would seem that the apparatus is to be put in at three different State prisons, Auburn, Clinton, and Sing Sing.

Some idea of the interest taken in electricity in educational circles is given by the announcement that Princeton College is now to establish a course of electrical engineering. Princeton is situated in New Jersey, not far from this city. It will be remembered that Columbia College here is also about to establish a post-graduate course in electrical engineering; and as we have Stevens Institute just across the Hudson river in Hoboken, and Cornell University in the northern part of the State, to say nothing of Harvard and Yale within hailing distance in New England, and the University of Pennsylvania and John Hopkins University to the south of us, it will be seen that the facilities for electrical training and study are rapidly multiplying themselves, and that there should therefore soon be no want of very well-equipped young electricians for all branches of electrical science and industry.

Stockport.—Steps are being taken in this town to form an electric lighting company.

CORRESPONDENCE.

BRITISH ASSOCIATION LIGHTNING ROD DISCUSSION.

TO THE EDITOR OF THE ELECTRICIAN.

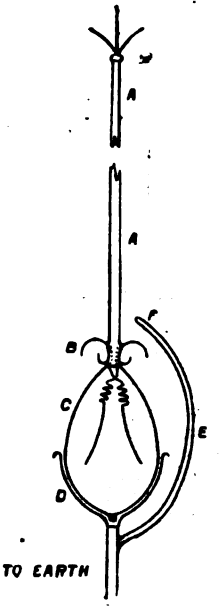
SIR: I have just seen what purports to be a report of the lightning rod discussion at Bath, as published in the annual volume of the British Association. Its appearance in that volume may lead readers to suppose that it is a corrected and authorised report of what was said. So far as I am concerned this is certainly not the case, and it bears evidence of being practically unedited. Speaking for myself, I find I am made to talk a lot of nonsense, and occasionally to say things the exact contrary of what I could have intended. I judge that the same thing applies to others, but for myself I write to disclaim all responsibility for the production.—Yours, &c.,

OLIVER J. LODGE.

LIGHTNING PROTECTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Seeing the discussion *re* Lightning Conductors, and having experimented some two years on disruptive discharges, I should feel obliged if you would insert the following description of a contrivance I devised in the early part of last year, and which I think might prove useful in the dissipation of electric energy besides. I should much like to know the opinion of some of your readers on the matter.



AA is a lightning conductor or its equivalent, B an oil insulator through which the conductor passes into a large glass bulb C, which has previously been exhausted by means of a high vacuum pump, and in which is contained two metal strips of aluminium after the style of an electroscope, which are connected to the conductor, where it passes into the bulb, by circular springs; towards the bottom on the outside of bulb is a thin metal cup full of oil D, in connection with the earth, from which projects a side conductor E, which terminates at its upper end with a point F, nearly at right angles to A.

On any electrical excitation of the conductor A the metal strips diverge and give up their charge to the attenuated vapour condensed on the inside of sides of bulb, which produces a counter excitation on the metal cup D, and which eventually culminates in a spark from A to E, and so lowers the potential of A, and, therefore, the source from which A derives its energy.

This simple device with a few modifications seems to me to answer equally well either as a lightning arrestor or as an ordinary condenser.

In the actual experiments made by me I used a large Edison lamp with a broken horse-shoe filament, which answered every requirement; and I found that Leyden jars so made had a much

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greater insulation and a larger capacity than the usual jars constructed for electrical discharges generally, besides costing little to make, as large users of incandescent lamps are willing (or at least were good enough to do so in my case) to give a choice out of a large number of broken or disused lamps which are of no use to them. Leyden jars so constructed are very useful for obtaining a brush discharge only if the vacuum is very high, as they gradually give up their charge and do not spark; by a suitable and careful choice of lamps a Leyden jar battery can be made to give either a quick, slow, or brush discharge, and this depends, as far as I can judge, on the degree of residual vapour in the bulb.—Yours, &c.,

May 18, 1889. ALFRED TREEBY.

MR. HAROLD BROWN AND THE WESTINGHOUSE SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the Westinghouse Electric Company are making strenuous efforts to introduce their apparatus, and are urging in its favour its "economy" as well as its "safety," and as I am frequently consulted on the subject, I felt authorised to address to Mr. Westinghouse, on the 4th of April, a registered letter, a copy of which I enclose, giving him a fair opportunity to have his remarkable claims demonstrated at my expense. The official receipt for the letter has long since reached me, but there has been no reply. You will remember that Mr. Westinghouse and his experts pronounced this current "safe" and "harmless," and that they have violently attacked the writer for maintaining and proving that it was dangerous. As a result of my work, the New York State authorities, after a long and thorough investigation, have purchased for electrical execution three Westinghouse alternating-current dynamos, built for electric lighting. Having thus proved my point as far as the danger of the apparatus is concerned, I am anxious to have its commercial value definitely settled by the proposed test. I would, therefore, be glad to receive from you any suggestions concerning methods, or any results of your experience with the alternating current that you may care to place at my disposal. In return I shall take pleasure in sending you copy of report of the tests when completed.—Yours, &c., HAROLD P. BROWN.

[COPY.]

DEAR SIR: The public admission made at Hamilton by Mr. Stillwell, your electrician, that he knew of at least three men killed by the Westinghouse alternating current which you have pronounced safe, and the adoption of the same current by the State of New York for electrical executions, are sufficient reasons for your failure to accept my challenge of December 18, 1888. I then offered to take the continuous current from hand to hand to prove what you deny, if you would take the alternating current at the same pressure and for the same number of seconds. You did not dare to risk your life to prove the sincerity of your statements concerning the safety of the Westinghouse alternating current. Will you now dare to risk your money to substantiate your claims as to the efficiency of the Westinghouse alternating-current system?

If so, I hereby give you an opportunity to sell another electric light station (with 650 lamps of 16 candle-power each), and obtain an extensive advertisement at my expense.

You have asserted for many months, both by representations of yourself and agents and by authorised advertisements in electrical and other papers, that "50 per cent. more light from a given expenditure of power (fuel)" is guaranteed by the Westinghouse Electric Company than can be obtained by any continuous ("direct") current system.

If it is possible to convert force from one form into another, and gain 50 per cent. in the operation, your company has made the most wonderful discovery of modern times, which, carried to its logical conclusion, will give us perpetual motion by a series of conversions from high to low tension, or the reverse.

To substantiate this remarkable claim I challenge you to send a complete 650-light Westinghouse alternating-current plant, with not less than thirty converters, to the Electrical Testing Bureau of the John Hopkins University, to be there installed by your own experts, and left for a three months' test. I will send a plant of the same capacity of the Mather, Schuyler, Jenney or Thomson-Houston continuous-current apparatus.

The electricians of the Bureau shall then determine the efficiency of the dynamos from one lamp only to full capacity by dynamometer; the efficiency and life of lamps and efficiency of converters under full load, half-load, a single lamp on each converter, and with secondaries open. The apparatus supplied to be standard commercial make, and burned-out lamps not to be replaced. At the end of the tests the Bureau's reports to be published, and if the Westinghouse alternating system gives 50 per cent. more light from the same expenditure of power, or proves to be that much more economical in running expenses, then I will pay all expenses of tests of both apparatus and will purchase your plant at list price to present to the University.

If your apparatus fails to give 50 per cent. more light from the same expenditure of power, then you are to pay all expenses of the tests of both apparatus and to purchase the continuous-current apparatus supplied by me at list price and present same to the University.

If you claim that the remarkable advantages of the Westinghouse system are due to the use of the Westinghouse engine, which has so extensive a sale and is so highly recommended by your company, you can use it in the test, and I will arrange to operate against it some one of the standard high-speed automatic cut-off engines.

If my challenge is accepted each apparatus is to have one expert in attendance, but he is not to be permitted to interfere with the machinery in any way, or to take part in any of the tests.

If you fail to accept this challenge within a reasonable time, and are disinclined to have the value of the Westinghouse Electric Company's guarantees publicly established, I shall feel at liberty to personally submit your apparatus to the Bureau for an efficiency test, and shall publish their report.—Sincerely yours,

HAROLD P. BROWN, Electrical Engineer.

45 and 47, Wall-street, New York, April 4, 1889.

Geo. Westinghouse, jun., President Westinghouse Electric Company, Pittsburgh, Pa.

[Some interesting remarks on this subject will be found in our "American Notes" this week.—ED. *E.*]

PATENT RECORD.

APPLICATIONS FOR PATENTS.

April 27, 1889.

7,023. R. SNOWDON. Manchester. Improvements in electric meters.

7,037. W. BLYTH. Glasgow. Improvements in electricity meters.

7,038. W. BALCH. London. Improvements in electric battery cells for lighting or for other purposes.

April 29, 1889.

7,088. R. SNOWDON. Chesterfield. Improvements in electric measuring instruments.

7,127. G. E. VAUGHAN. London. Improvements in or connected with the brush contacts of electric railways (S. Trot, Nova Scotia).

7,129. A. J. HOWES. London. Improvements in arc electric lamps.

7,133. A. RECKENZAUN. London. Improvements in electric meters.

7,138. A. W. FITCH. London. Improvements in and connected with electric glow lamps (R. O. G. Drummond, South Africa).

April 30, 1889.

7,165. J. M. M. MUNRO. Glasgow. Apparatus for electrical distribution of energy.

7,193. W. E. ADENEY and L. SAUNDERSON. London. Improvements in the manufacture of electric arc carbons.

7,215. C. B. ASKEW and J. K. PUMPELLY. London. Improvements in secondary batteries.

May 2, 1889.

7,336. A. C. COCKBURN and J. N. COOPER. London. Improvements in apparatus for electrical communication for trains and similar purposes.

7,337. J. JACOMIN. London. Improvements in electric winding and striking clocks.

7,349. M. R. WARD. London. Improvements in the method and means of working the driving appliances on electrically propelled vehicles.

May 3, 1889.

7,356. C. MALTBY-NEWTON. Croydon. Improvements in galvanic or primary batteries.

7,395. W. S. BOULT. Birkenhead. Improvements in or relating to commutating alternating currents of electricity.

7,405. E. CORTES. London. Improved means for utilising terrestrial and atmospheric electricity for the production of motive power and other purposes (R. Z. Bayon, South Africa).

7,423. H. S. DOWSING and H. S. PRICE. London. Improved means or apparatus for driving rotary hair-brushes and the like by electricity

7,428. C. POLLAK. London. Improvements relating to electric accumulators or secondary batteries, and to the manufacture of plates or electrodes therefor.

May 4, 1889.

7,473. C. A. MCEVOY. London. Improvements in switch apparatus for electrical circuits.

7,475. C. B. CLAY. London. An improvement in telephonic signal apparatus.

7,499. E. MANVILLE and W. L. MADGEN. London. Improvements in the method of and means for producing low-tension alternating electric currents and applying same to sundry purposes.

7,506. J. A. TIMMIS. London. Improvements in the electric lighting of railway trains.

7,507. J. A. TIMMIS. London. Improvements in mechanically and electrically working, repeating and interlocking railway points and signal apparatus in conjunction with block instruments and the lighting of signal and station lamps.

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May 6, 1889.

7,522. H. SUMNER. Kilmarnock. An electric ignition for gas, petroleum, oil, or combustible vapour motor engines.

7,526. A. U. ALCOCK and H. GALOPIN. Manchester. An automatic compensating feed electric arc lamp.

7,568. G. H. JONES. London. Improvements relating to electric batteries.

May 7, 1889.

7,597. C. H. MEHNER. Liverpool. Dry galvanic cells.

7,600. B. C. C. CANT. Walthamstow. Improvements in electric indicators.

7,619. W. J. S. BARBER-STARKEY. Manchester. Improvements in and connected with electric batteries.

7,628. MIX and GENEST (Limited). Improvements in primary and secondary elements.

7,645. G. W. COOK. London. Improvements in underground conduits for electrical conductors.

7,647. S. S. WHEELER. London. Improvements in electric motors and dynamo-electric machines.

May 8, 1889.

7,673. A. W. HEAVISIDE. Newcastle-on-Tyne. Improvements in electric wire insulators.

7,719. P. SCHOOP. London. Improvements in electric or galvanic elements or cells.

SPECIFICATIONS PUBLISHED.

1888.

5,098. KRICBOOM. Electrical signalling for telephonic circuits. (Price 8d.)

5,162. MORDEY. Electric generators. (Price 8d.)

5,531. STATTER. Electric lighting, &c. (Price 8d.)

7,655. CROMPTON. Electric conductors, &c. (Price 1s.)

8,099. CROMPTON and others. Electrical hoists. (Price 8d.)

17,267. LAKE (Klames). Electric apparatus for propelling tramway cars, &c. (Price 8d.)

6,680. VAUGHAN (Trott). Electric railways. (Price 8d.)

6,907. IMMISCH. Storage batteries. (Price 8d.)

6,909. HAUGHTON. Dynamo-electric machines. (Price 8d.)

6,961. NUSSBAUM. Automatic electric batteries. (Price 8d.)

7,083. FORD. Electric medical batteries. (Price 8d.)

10,107. SNELL. Casing for electrical conductors. (Price 8d.)

3,679. LAKE (Thomson). Regulating electric currents. (Price 8d.)

4,336. SPENCER (Piaste). Electrical switches. (Price 8d.)

1889.

3,813. BENNETT. Telephonic switching apparatus. (Price 8d.)

3,870. LAKE (Lugo). Electric motors, &c. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Woodhouse and Rawson (Limited).

Lieut.-General Sir JOHN STOKES, K.C.B., presided at the Cannon-street Hotel, on the 17th inst., over an extraordinary general meeting of the shareholders in this company.

The SECRETARY (Mr. J. SHURMER) read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, I have much pleasure in meeting you again and in being able to put before you not only very satisfactory results but also good prospects for the future. With regard to the general business of the Company, the advance in the electrical work that I mentioned at the meeting in December last has continued, and during the last few months there has been a great extension of electrical enterprise in all directions. Our business is steadily progressing, and we are glad to say that with regard to our installations the really good work we do is fully appreciated. When we consider the large amount of central station work that is being done, not only in London (twenty-one central stations), but in other parts of England and the Continent, the outlook is very encouraging. With regard to the contracts on hand for the maintenance of installations, owing to the good quality of the work done and material supplied we find the maintenance is costing less than we originally anticipated, and is giving general satisfaction. Our general business has steadily increased outside of electrical work, and we have taken out and acquired several valuable patents, chiefly electrical, during the past year. Abroad there has been a gratifying and rapid increase in our business, and I am happy to announce that we have just satisfactorily carried through an important negotiation, whereby we make a large profit, and we also have made arrangements whereby we secure the supply of considerable quantities of the various goods required by several leading electrical companies. With regard to the Elmore patents, in which we are interested, the Elmore Patent Copper Depositing Company, which I mentioned at the last meeting, has been successfully brought out, being subscribed for nearly four times over, since which we have put up a plant abroad, and more than proved the statements that were made as to the value of the process. The trials were witnessed by some of the most experienced men in the copper industry, and proved thoroughly satisfactory on every point. I myself saw some articles being made and the experiments going on, and noted the great surprise of the technical men at the very high quality of the copper, and the extraordinary results, they acknowledging the low cost of manufacture, the high quality of the articles made, and the other advantages. I may mention that the workman employed actually refused at first to make the experiments with the copper as requested, being, as he said, certain of failure, but which proved easy and perfectly successful. In fact it is now undoubted that this is one of the most important of recent discoveries, and it is very gratifying that it has fallen to this Company to secure its development. With regard to the amalgamation and sale to the new Company, this is on the lines approved of by the last meeting, viz., that you receive now your dividends up to the 30th June last, together with a bonus of 10 per cent. upon the amounts paid up on your shares from the new Company, and besides this, certain assets are to be distributed amongst you. It is expected that these will amount to a substantial bonus, and that as the new Company takes over the businesses from fixed dates as going concerns, it will be in a position to pay a considerable interim dividend in July next. The Directors have not taken this step without mature thought and deliberation, and as they themselves hold more than a tenth of the whole capital of this Company, you may rest assured that it is in the interest of the shareholders. The scheme has also been approved by most of the large shareholders. I may say that the new company will be a strong, compact organisation, with a first-rate board and the same supervision and staff as we have now, together with the advantages of the staff from the other companies. From its constitution, which is an amalgamation of manufacturing, supply, and installation interests, it will be capable of efficiently undertaking not only almost every description of electrical work, but the large contracts that are expected. As you are aware, at present the major portion of the profits, after paying 10 per cent., goes to the holders of the Founders' Shares. By the sale to the new company these shares are done away with, thus enabling us to pay larger dividends than before. The dividend now declared makes 12 per cent. for the year. Satisfactory as this is, I may say that from earnings already made by the companies to be amalgamated the new company will be in a position to pay in July next a dividend at a still higher rate, and we anticipate a considerable demand for the shares, the issue of which will take place almost immediately. He concluded by moving a resolution for the adoption of the accounts and the payment of the dividend mentioned.

Mr. LAMBERT seconded the motion.

In answer to Mr. FELLOWS,

The CHAIRMAN stated that the new Company would take over the undertaking of Woodhouse and Rawson from January 1st this year. The motion was then put and carried. Continuing, the Chairman proposed:—

"That the agreement, a draft of which has been produced to this meeting and initialled by the Secretary, is hereby approved, and the Directors are hereby authorised to enter into the same and to carry the same into effect."

The general conditions of the agreement he had sketched to them in what he had stated.

Mr. RAWSON then went through the clauses of the agreement, which provided that the vendor company should sell and the purchasing company should buy, as from January 1st last, all property of Woodhouse and Rawson (Limited) with the exception of the latter's interest in certain assets, which were going to be distributed among the shareholders, and also with the exception of the book debts due to and by the vendor Company. The consideration for the purchase was to be £200,500, being 7,700 Ordinary shares, 600 Preference shares, and £20,000 in Debentures. That was arranged, Mr. Rawson pointed out, so that they might get a Stock Exchange quotation in the new Company. The largest amount was taken in the Ordinary and Preference shares and Debentures of the new Company that was allowed, and the result of that was that the shareholders of Woodhouse and Rawson would have to take a certain amount of cash, to be arranged afterwards by the liquidator. A certain amount of cash was to be paid in seven days, and the remainder was to be paid as the properties were handed over. The shares in the new Company were to be issued fully paid. The new Company was to adopt, fulfil and perform all contracts binding on the old Company, and was to keep the old Company indemnified against liabilities. From the beginning of January, 1889, the new Company should be deemed to have carried on the business of the old Company, and the profits made since January 1st (which amounted roughly to £20,000) were to be taken over by the new Company. The old Company was to take all the necessary steps to give effect to the agreement.

A SHAREHOLDER said he believed that at the last meeting the Chairman stated that the shareholders would not be expected to take shares in the new Company, but that they could, if they thought proper, take cash for their original shares.

The CHAIRMAN: That will be so if the Company is satisfactorily launched.

Mr. RAWSON: When the Company is satisfactorily launched, no doubt that will be so. The present arrangement is that we shall get a large amount of cash, quite sufficient to more than pay out any shareholder who wants to be paid out.

The SHAREHOLDER: It was stated definitely at the last meeting that that would be so.

The SOLICITOR: It is a right to every shareholder.

Colonel PATTEN seconded the motion, which was then put to the meeting and carried unanimously.

The proceedings then terminated,

Elmore's Patent Copper Depositing Company (Limited).

The statutory meeting of this Company was held on the 17th inst. at the City Terminus Hotel, Cannon-street, Sir John Morris, K.C.S.I., in the chair.

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The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said that the whole of the issue of shares in the Company had been allotted. A suitable site for the conduct of their business had been obtained near Leeds, most conveniently situated on the Aire and Calder Navigation Canal on the one side and the Midland main line on the other. The rates for the delivery of raw material to the works and for the despatch of manufactured goods could hardly be more favourable than they were in respect of these works. The management had been arranging to obtain tenders for the erection of suitable buildings, &c., and the contractor had already commenced the erection of the same, and had undertaken to have them completed by the end of June. Orders for the necessary plant and machinery have also long since been placed, and will, so far as they could see, be ready for delivery by the time our buildings are ready to receive the same. Some preliminary tests and experiments had been carried out under the immediate and careful supervision of the managers, and some tubes produced which, upon testing, had yielded the most gratifying results; and, so far as it is allowable to judge of the process from this small scale, there can be no reasonable doubt that the process is as valuable and profitable as was foreshadowed in the prospectus issued to the public. Some of these tubes were in the room that day for examination, and what makes these more noteworthy is the fact that the plant used in their production was of a somewhat obsolete character, and not so reliable as that about to be installed at the new works. A most satisfactory report had been received in reference to these experiments. It was also very satisfactory to know that the rise and fall in the price of copper did not materially affect the prosperity of the Company, though, of course, the lower the price of copper the larger the business likely to be done. Four additional members had been elected to the Board since the promotion of the Company, viz., Mr. F. L. Rawson, of Woodhouse and Rawson, Limited, whose technical knowledge is most valuable to the Company; Mr. G. C. V. Holmes, and Messrs. J. J. Atkinson and J. T. Cooper, the two latter gentlemen being the representatives of the vendors. The Company's managers, Messrs. F. E. and A. S. Elmore, were busily engaged in connection with the erection of the works and installation of the plant, and trial tests already referred to were carried out under the supervision of these gentlemen.

General LIGHT said he saw Mr. Stepney Rawson present, and he believed he had been in France, and had seen the working of the process. He thought any information he could give them would be interesting.

Another SHAREHOLDER said he noticed that a certain firm were making arrangements to carry on the system on a royalty. He should like to know if they were carrying it out.

The CHAIRMAN said: Until they had their own works, and could see the results, they thought it better to defer the conclusion of the negotiations.

Mr. F. L. RAWSON said he was not aware that there were any tubes in use in boilers. This company was not so much engaged in cheap work, such as boiler tubes, but more in the manufacture of larger things. He might say that he had a statement of the amount of copper likely to be used, by one of the officials of this company, and the figures were something enormous, a long way more than himself and the other members of the Board thought was possible. A tube 12-in. in diameter, solid-drawn, cost 3s. a pound to make, and they thought they would be able to make them for 2d. or 3d. a pound; so that there was no use their going into the manufacture of boiler tubes when there were numbers of articles which cost a great amount of money, and could not be made except by the Elmore process.

Mr. DICKINSON asked what was being done with regard to steam pipes.

Mr. F. L. RAWSON said it was very unfortunate that Mr. Elmore, the father of their Managing Directors, was ill and unable to leave his bed. He could, however, say that the large steam pipes had been fully tested by well-known firms in the copper trade, who all agreed as to the extraordinary quality of the copper. Several of them had told him that they had no idea it was possible to make copper of that quality at all. Not only did they intend to make the large pipes, but there was a large demand for copper platings, which were now made in large quantities, and that was one reason for changing their works, so as to be on the direct main line of the Midland Railway.

Mr. STEPNEY RAWSON said some months ago, before the Company was brought out, he had certain figures brought before him as the result of previous trials made by Mr. Elmore and his sons. On examining them he was unable to find any flaw, but his verdict was they were too good to be true. When it became his business to go and examine into these trials he went to pick holes in the process, if he could find any, but he was as unable to find any holes in the process as he was to find fault with the previous figures. The more complete trial extended over ten days. They were working night and day, and a great part of the time he was actually present, till the simplicity of the process began at last to pall upon one. There was absolutely nothing to do except to keep the engine going; the rest of it was purely automatic, and became rather wearisome from its absolute simplicity. The keynote was no doubt the burnishing. It seemed a small difference from doing a thing without rubbing and doing it with rubbing; but that was the key to the whole process. Now, it might occur to some of them that he was speaking only as an electrician, and that would be perfectly justifiable; but he saw there many technical and practical authorities on copper working, who were as much astonished as he was: commencing with absolute doubt of the possible result of the statements, proceeding from that to incredulity, and at last winding up with confident belief. The proofs were on their own machines, attended by their own workmen; and there was no possible better proof than to see a practical man start with the idea that a certain thing could not be done, and then for him to find that he could do it himself. That he saw on many separate occasions, and from the more technical to the practical man at the finish there remained nothing but one implicit belief in the value of the process. It became necessary at the end of the tests to invent more stringent tests than ordinary copper was usually put to. These tests were invented by people who were looking into it, and many of them were proposed ironically. The results of these tests were absolutely successful, leaving over and above what they had proposed a very considerable margin, making it possible to put the copper to still further tests than they had ironically proposed. One test was submitted to a large meeting of the most capable authorities on copper in the world, and the next day it was carried out, with the result that perhaps the greatest authority in the world expressed himself absolutely satisfied and a thorough believer in the process. From the practical side of the question there could be no doubt of the value of the process. (Applause.)

The CHAIRMAN thought their very best thanks were due to Mr. Stepney Rawson for the information he had given them.

A vote of thanks to the Chairman closed the proceedings.

Submarine Cables Trust.

The following is the report of the Trustees for the financial year to the 15th April last, to be presented at the eighteenth ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, 50, Old Broad-street, E.C., this day (Friday) at three o'clock:—

The revenue for the period, including the balance brought from the previous accounts, viz., £1,448. 5s. 5d., amounted to £20,567. 3s. 7d. The coupon due on 15th April, 1888, was paid in two instalments, viz.—£2. 10s. on 15th October, and the balance of 10s. on 15th November last. £2. 12s. 6d. of the coupon due 15th October, 1888, was paid on the 15th April last. The balance of 7s. 6d. will be paid on the 15th inst. The expenses of the Trust amounted to £1,383. 19s. 7d., and the

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS; BAGOT STREET, BIRMINGHAM.

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payments on account of the coupons to £19,018. 2s. 6d., together £20,402. 2s. 1d., leaving a balance of £165. 1s. 6d. to be carried forward. A table showing the original and present investments of the Trust is appended to the report. The meeting will have to elect two auditors for the current year; Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

Consolidated Telephone Construction and Maintenance Company (Limited).

Report for the year ended March 31, 1889, to be presented at the eighth annual general meeting of the Company, to be held at the Cannon-street Hotel, London, E.C., on Thursday, the 30th inst., at 12 o'clock :—

The accounts show a net profit of £11,914. 4s. 3d., which, with the amount carried forward from last year, leaves a balance of £13,286. 14s. 2d. for disposal, after making provision for doubtful debts. The Directors propose to deal with this amount as follows, viz.: to pay a further dividend of £7 per cent. for the half-year, making with the interim dividend paid in November last, £6 per cent. for the year; writing off the sum of £520. 4s. 6d. for depreciation of plant, machinery and furniture; and the sum of £2,000 from goodwill, patent rights, &c., thus leaving a balance of £1,568. 17s. 7d. to carry forward.

During the year the Directors have received a further sum of £3,044. 18s. 6d. on account of profit arising from the liquidation of the River Plate business, which is included in the above statement, and there is still a balance to be received under that head.

The action in Belgium in relation to the patents, in which the Edison Gower-Bell Telephone Company of Europe is interested, is now in the hands of experts, to decide whether the instruments used in Belgium are infringements of the Edison patent. It is difficult to see how they can decide otherwise, as the law courts of England and the United States have repeatedly decided that they are infringements.

Your Directors are pleased to state that the working of the factory under their direct management has proceeded very satisfactorily, with the results as shown in the balance-sheet.

The relations between the United Telephone Company and this Company continue to be of an amicable nature, and your Board are glad to report that increased orders have been received during the past year from the Managing Director of that Company. The subsidiary companies continue to make most satisfactory progress, as is shown by the following statement :—

	Year ended March 31.					
	Subscribers.		Rental.		Increase.	
	1888.	1889.	1888.	1889.	Subscribers.	Rental.
			£	£		£
Telephone Co. of Austria	2,036	2,441	13,483	15,588	405	2,105
Anglo-Portuguese Telephone Co...	1,500	1,713	9,772	11,077	213	1,305
Total increase for the year.....					618	£3,410

For some time your Board have had under consideration the necessity of finding working capital for the subsidiary companies. With this object in view it will be seen that notice is now given for taking the necessary legal steps to carry out this proposal, and the attention of the shareholders is called to the prospectus accompanying the report relating to the subject.

In accordance with the Articles of Association the following Directors retire by rotation, and being eligible, offer themselves for re-election, viz.: J. H. Buckingham, Esq., and Richard Van Zeller, Esq.

The auditors, J. G. Griffiths, Esq., F.C.A. (Messrs. Deloitte, Dever, Griffiths and Co.), and A. E. Green, Esq., F.S.A.A., also retire, and offer themselves for re-election.

An extraordinary general meeting will be held immediately following the ordinary general meeting, when the following resolutions will be proposed :—

"*That the capital be increased to* £307,545 *by the creation of* 75,000 *new shares of* £1 *each.*"

"*That the new shares be called Preference Shares, and that the holders thereof be entitled to a preferential dividend at the rate of* £6 *per cent. per annum, payable out of the profits of each year without any right in case of deficiency to resort to the profits of subsequent years.*"

"*That the holders of the said Preference Shares shall be entitled on any distribution of the assets of the Company to be repaid in the first place the amount paid up on the Preference Shares held by them respectively, before any payment out of such assets to the other members of the Company.*"

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended May 17, 1889, amounted to £4,932.

THE MEXICAN TELEPHONE COMPANY.—The report of the Mexican Telephone Company, an American company with a nominal capital of $2,000,000, managed by a Board in the United States, shows the evils of working with too large a capital, which in the present case appears to have been due to an over-estimate of the business likely to be done by a telephone company in Mexico. The annual statement of the Company showed the number of telephone subscribers as follows :—In Mexico city, 538; Guadalajara, 125; Puebla, 50; Oaxaca, 44; Merida, 85. The Merida district (southern province of Yucatan) was the most prosperous, the receipts having increased from $3,598 to $5,190. The accounts of the Mexican office showed receipts $55,544, expenditure $53,370, and net earnings $2,174, making with the amount forward a balance on 1st March last of $2,295. The receipts of the Boston office were $1,299, but the expenses were $4,252. There was, therefore, a small deficit upon the whole undertaking.

THE SHEFFIELD TELEPHONE EXCHANGE AND ELECTRIC LIGHT COMPANY (LIMITED).—The first annual meeting of shareholders was held at the offices of the Company in Commercial-street on Thursday, May 16th, at noon. A satisfactory report was presented to the shareholders, of whom there was a good attendance, and a dividend of 7½ per cent., free of income tax, was declared, in addition to the sum of £793, which was carried to a reserve fund.

THE UNION ELECTRIC COMPANY OF AUSTRALIA (LIMITED) is being formed in Melbourne to purchase the businesses of the Electric Light and Power Supply Company of Australia (Limited) and the Southern Electric Company (Limited), Melbourne. Its capital is £1,000,000 in £1 shares. The Chairman of the new Company is Col. J. M. Templeton; Managing Director, Mr. T. T. Draper; Secretary, Mr. Charles Flesch, and the offices are situate at No. 66, Elizabeth-street, Melbourne. The new Company will have the exclusive agencies in Australia of the manufactures of Elwell Parker (Limited) and the Thomson-Houston Company.

UNITED TELEPHONE COMPANY.—Subject to audit the directors of this company have decided to recommend, at the general meeting to be held on May 29, a dividend for the half-year ending April 30 last at the rate of 12s. 6d. per fully-paid share, less income-tax, making, with the interim distribution, 17½ per cent. on the paid-up capital for the twelve months.

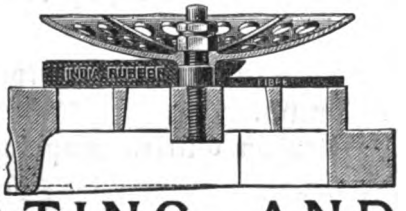
WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended May 17, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,544.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this Company for the half-month ended May 15, 1889, show an increase of £289 as compared with the corresponding period last year.

REMOVAL.—Messrs. Fairholme and Co., proprietors of the Cyclostyle Copying Apparatus, have removed to 34, Snow-hill, Holborn Viaduct, London, E.C.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, May 22, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 22, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	51½ 52⅛	3 16 2	Jan., Apr., July, Oct.	52½	52
2,614,820	Stock	25/0	Do. Preferred	87½ 88⅛	4 10 5	,, ,,	88¼	87¼
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	18⅝	...
120,000	£10	3/0	Brazilian Submarine	13¾ 14⅛	4 19 1	Mar., June, Oct., Dec.	14 1/16	13⅞
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14⅝	14 5/16
6,000	10	10/0	Do. Preference 10%	19 20	5 0 0	,, ,,	19½	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3½ 4¼	4 4 8	March & September	3⅝	...
6,000	5	5/0	Do. Preference 10%	8⅛ 9⅛	5 5 3	April and October	...	...
60,710	20	3/6	Direct United States	10⅛ 10⅞	5 2 4	Jan., Apr., July, Oct.	10⅝	...
380,000	10	2/6	Eastern	13⅛ 13⅝	4 9 9	,, ,,	13⅜	13 3/16
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝ 15¼	3 18 8	,, ,,	14⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109¼	108
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	5/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	103½	...
179,177	10	3/0	Globe Telegraph and Trust	7⅝ 7⅞	5 11 3	Jan., Apr., July, Oct.	7⅞	7½
178,992	10	3/0	Do. 6 per Cent. Preference	14½ 14⅞	4 1 4	,, ,,	14⅞	14⅛
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	15⅞	15⅝
17,000	25	2/6	Indo-European	39 41	6 1 11	April and October	...	...
9,000	8	8/0	Reuter's	7 7½	5 6 8	April and October	7	...
15,609	10	3/0	West African Telegraph	8½ 9½	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	100 103	4 17 1	March & September	102½	...
80,000	10	6/0	West Coast of America	10 10½	4 15 3	January and July	10⅝	10 3/16
150,000	100	8%	Do. Debentures 8%	120 124	6 9 1	June and December	...	...
88,321	10	nil.	West India and Panama	2⅛ 2⅜	...	...	2⅜	2 1/16
84,563	10	12/0*	Do. 1st Preference 6%	11½ 12	...	April and October	11⅞	11 1/16
4,669	10	†	Do. 6 per Cent. 2nd Preference	13 14	...	...	14	...
45,181	15	6/0	Western Brazilian	12⅞ 13¼	5 13 4	March & September	13 3/16	12⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	4½d.	Consolidated Telephone and Maintenance	1⅜ 1⅝	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 1	...	...	...
80,000	5	5/0	United	15½ 16¼	4 12 4	June and December	16⅛	15⅞
55,000	5	3/0	United River Plate	6 6¼	...	January and July	6¼	6
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 3⅝	...	...	3⅝	3½
28,692	5	2/0	Do. (fully paid)	4 4¼	...	February & August	...	...
79,334	5	...	Swan United (£3. 10s. paid)	2⅝ 3¼	...	...	3	2 1/16
			MISCELLANEOUS.					
87,350	12	36/0	Telegraph Construction and Maintenance	41 43	5 11 9	March and July	42½	42
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19½ 20½	4 17 7	February & August	20	19

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
J. G. Statter & Co., Limited.

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 576.—Vol. XXIII. FRIDAY, MAY 31, 1889. Price Fourpence.

NOTES.

Although no one would venture to deny that where due precaution is not observed ships' compasses might easily suffer disturbance from the electric lighting appliances, yet it is happily true that the experience of ten years, extending over an enormous number of vessels, has not hitherto disclosed a single disaster arising from this cause. None the less should we be grateful to the President of the Institute of Electrical Engineers for directing attention to a question whose importance it would be difficult to over-estimate, especially since complete immunity from danger is easily attained, as Sir William Thomson was careful to point out. Whether or not it is necessary or desirable absolutely to prohibit the use of the single-wire system (with "ship-return") is perhaps a doubtful point in view of the remarkably good results which in the great majority of cases have attended its use. Mr. Alexander Siemens was able to state that in the whole course of his experience only two or three instances of the compass being affected by this method of wiring had come under his notice. We have reason to believe that this statement would be paralleled in the case of other firms. On the other hand it is impossible to dispute Sir William's contention that the single-wire system carries with it elements of danger in this respect, which are obviated by the employment of properly arranged double wires, or by the use of the alternate current. With regard to the latter method, it seems to us to be quite an open question whether, at least for large ships, the use of modern alternate current appliances (with or without a ship return for the secondaries) might not prove an economical as well as a perfectly practicable method of installation. Meanwhile the lesson to be learnt is that contractors should themselves ascertain, and, if desired, should certify, that the compass is free from disturbance caused by the electric lighting.

On Friday morning last, at the invitation of the Anglo-American Brush Corporation, a party consisting chiefly of the members of the Council of the Electrical Engineers (including the President) and the representatives of the technical press, assembled at the works in Belvedere-road to witness a repetition of the remarkable experiments on the Mordey Alternator, which were described in the Paper read by Mr. Mordey on the previous evening (see *The Electrician*, May 24th, p. 66). Of the experiments themselves we can add nothing to the lucid description given by Mr. Mordey except to say that each experiment was attended with perfect success, and as a demonstration of the entire practicability of alternate-current parallel working nothing further could possibly be desired. Since the above was written we learn that in a subsequent trial the full load of 50 h.-p. was put upon the machine during a continuous run, with the same success.

An ingenious and determined attempt to intercept the signals passing along the Marseilles cable of the Direct Spanish Company was recently discovered in the course of some repairs to the underground lines in the streets of Barcelona. The Superintendent found that at one spot the ground had been undermined and the four cables cut, the conductors on both sides being connected to insulated wires, which were taken to the wall of the house opposite. Outside this house the leads from each cable were connected together by a binding screw, so that communication between Marseilles and Barcelona was not interrupted. A careful inquiry was at once instituted by the authorities, and it was speedily discovered that the wires had been, at a period which can be traced, led into the cellar of the house opposite the mine, the hole in the wall having since been carefully bricked and plastered up. Fortunately the Direct Spanish Telegraph Company has, in consequence of certain occurrences which took place at an earlier period, adopted a system of working which makes it impossible to read the intercepted signals. As an instance of the ingenuity with which the attempt was made it may be mentioned that, instead of merely binding the wires forming the sheathing of the cables with small wire, clasps with screws to tighten them had been provided, which kept the outer wires in place after the cables had been cut through. The Spanish Government Telegraph Administration have taken the matter in hand, and every effort is being made by the authorities to secure the culprits. It is not necessary to go very far to seek the reason for this nefarious scheme. The Marseilles cable carries the important Bourse telegrams between Paris and Barcelona, and early information during the recent speculation fever was well worth the risk of detection. As it happened, however, owing to the precautions alluded to the design must have been entirely frustrated.

At the meeting of the Physical Society last Saturday Prof. Silvanus Thompson described a very pretty experiment, illustrating in a very direct manner the magnetic rotation of the plane of polarisation of a beam of light. The eye of a codfish properly mounted is traversed by a beam of polarised light, thrown, by means of a projecting lantern, upon a screen. A

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clearly-defined black cross is then visible on a bright ground. If the beam of light is made to traverse a piece of heavy glass, or some other substance in which the magnetic rotation is considerable, then, as soon as the magnetising current is turned on, the cross is seen to rotate upon its axis with a rapid jerk through an angle depending on the thickness of the glass and the strength of the magnetic field. On breaking the magnetising circuit the cross jerks back to its former position with the same rapidity as before. The magnetic rotation was not exhibited at the meeting of the Society, but the black cross was projected upon a screen and caused to rotate through various angles by the interposition of plates of glass of different thicknesses. It forms a very pretty lecture experiment, and as the author pointed out, the proof of rotation is much more direct, and therefore more easily grasped, than the ordinary method of inferring it from the fact that in order to reproduce extinction after closing the magnetising circuit, or introducing a plate of quartz, as the case may be, one of the prisms has to be rotated through a certain angle.

In another column will be found the text of the circular in which the Directors of the United Telephone Company announce the terms which have been agreed to in respect of the amalgamation of the three leading Companies. It will be seen that the scheme is precisely in accordance with the arrangement which we foreshadowed in our issue of the 3rd inst. (p. 725). It is proposed that the United and the Lancashire and Cheshire Companies shall be absorbed by the National Company, the terms of transfer being £12. 10s. of new consolidated shares for each share of the United, £1. 6s. 3d. for the Lancashire, and £5 each for the National. We further understand that there is no ground for supposing that the Postmaster-General views the amalgamation with either dislike or apprehension; on the contrary, we believe the suggestion that the National Company should absorb the others came from Mr. Raikes himself. It further seems that he was precluded from sanctioning the transfer of the Licenses to a new company, as at first proposed, by the terms of the original concessions.

In our issue of May 10th we referred to the indignation which had been excited by the action of the Directors of the New Telephone Company in abandoning to their fate the purchasers of instruments which were supposed to be fully guaranteed. We now learn that this indignation has culminated in the formation of a strong combination, which, acting under legal advice, is about to commence legal proceedings to test the actual position.

The long outstanding question as to the true nature of diamagnetic action, over which Tyndall and Faraday long waged war, and agreed finally to differ, seems at length to be on the point of settlement. Mr. J. Parker, in the May number of the *Phil. Mag.*, followed by M. Duhem in the *Comptes Rendus* (20th March, 1889), have each attacked the question from the side of Thermodynamics. Mr. Parker shows that the phenomenon of diamagnetism, if interpreted in Tyndall's sense, *i.e.*, the existence of polarity opposite to that of paramagnetics, implies the contradiction of Carnot's principle, according to which we have been taught that it is impossible to obtain work by the transfer of heat from a cold body to a hotter. M. P. Duhem, after studying Mr. Parker's note, has been emboldened to go further, and by applying thermodynamic principles to the equations of magnetic induction he announces definitely that *the existence of diamagnetic bodies* [per se] *is incompatible with the principles of thermodynamics.* Becquerel's hypothesis (*i.e.*, that diamagnetism is merely the resultant of the magnetic forces acting upon the body and the medium in which it is suspended in the case when the permeability of the latter is the greater) would therefore seem to hold the field. In *The Electrician* of June 8th, 1888, we made some endeavour to analyse the question from the modern standpoint, and on purely physical grounds we arrived at the same conclusion.

The function of the condenser in an ordinary induction coil, although apparently a fairly simple matter, is in reality very little understood. We are inclined to believe that the explanation given by Dr. Fleming in another column contains the first complete and satisfactory analysis of the phenomena which actually occur.

The Students' *conversazione* at the Finsbury Technical College last week was very largely attended. Prof. Thompson talked pleasantly on "Arcs and Sparks" for about an hour and a-half, in which brief space of time he managed to sketch the history of the subject from the days of Otto von Guericke to those of Wimshurst and Macquaire, and to put the nerves of the non-technical members of his audience to a severe test by performing the apparently perilous feat of striking an arc in a bowl of paraffin oil. Those who were unable to digest the mild technicalities of Prof. Thompson's lecture could console themselves by listening to an excellent concert in the adjacent room. One of the most interesting features of the evening was the fine display of electrical apparatus. Amongst those exhibiting were Messrs. Woodhouse and Rawson, Messrs. Drake and Gorham, the Anglo-American Brush Corporation, the Acme Electric Company, and the General Electric Company. Messrs. Nalder Bros. and Co. showed a number of measuring instruments, including the latest type of secohmmeters. The Electric Apparatus Company exhibited some neatly finished electric bells with glass gongs, while one of Dr. Fleming's new standard resistance coils and some incandescent lamps for optical purposes were shown by the Edison-Swan Company. Messrs. Paterson and Cooper had an exhibit illustrating the construction of dynamo armatures, and the same firm also showed some large current ammeters. We must congratulate the students on a very successful and interesting entertainment.

We learn that some doubt is entertained by the Local Government Board as to whether the provisions of the Public Health Act, 1875, can be held to sanction the borrowing of money by local authorities for the purpose of undertaking the public supply of electricity. A case will shortly be submitted to the law officers of the Crown.

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THE Technical Education Bill, introduced this session by Sir HENRY ROSCOE, and read a second time on the 8th inst., being shorn of some of the objectionable features of last year's proposals, has a fairly good chance of very shortly becoming law. The definitions of subjects included in the term "technical education" are certainly rather wide, including as they do commercial arithmetic, commercial geography, modern languages, and shorthand; but as the powers conferred, and above all the attendance, are voluntary, little objection can be taken to the principle of the Bill; and if worked with moderation and judgment it will probably not be burdensome to the ratepayers in practice.

THE following interesting paragraph appeared in a recent issue of the *Lancet*:—

At Bologna the other day the Communal library (a singularly rich collection) was visited by the Assessor, Signor Dall' Olio, who, in the course of his search, came on a *scaffale* (book-case) containing a vast number of volumes which had not been classified. They were at once put in hand for entry on the catalogue, and, among other highly important treasure-trove, was found a hitherto unknown treatise by Galvani on electricity. Some account of its contents is awaited with unusual interest.

The *Lancet* does not quote any authority for the statement, and up to the present we have been unable to find any mention of the matter in the columns of our esteemed contemporary *L'Elettricita*, of Milan. We shall hope, notwithstanding, that the discovery will turn out to be genuine.

WE are indebted to Dr. PULUJ for a description of some experiments which he has recently been engaged upon, and which have also formed the subject of a communication to the Academy of Vienna. Dr. PULUJ takes a metallic ball and hangs it by a bi-filar suspension centrally over the pole of a vertical magnet. The ball is then twisted round so that when let go it tends to spin on its axis by the untwisting of the suspension. Dr. PULUJ finds that in such a case the ball tends to rotate around the pole of the magnet in the same direction as that in which it spins on its own axis, and that the effect is independent of the direction of the polarity of the magnet. A mathematical investigation shows that this is the necessary result of the generation of Foucault currents in the rotating ball.

Trinidad-Demerara Cable.—We are officially informed that the cable between Trinidad and Demerara is interrupted.

Institution of Civil Engineers.—At the last meeting of the Institution of Civil Engineers Sir William Thomson was elected an honorary member.

Birthday Honours.—Amongst the recipients of birthday honours was Prof. Gabriel Stokes, M.P., President of the Royal Society, who was created a baronet.

New Post Office Cable Ship.—We understand the Post Office is about to invite tenders for the construction of a new telegraph cable ship for use in H.M. Postal and Telegraph Service.

Electric Lighting on the Midland Railway.—On Wednesday night the Midland Railway Company used the electric light for the first time on the London and Manchester and Liverpool express.

Gas and Electricity.—The Gas Company of Metz contemplates the establishment of a central lighting station, and the Gas Company of Venice has obtained the shareholders' permission for a similar object.

Ballymoney.—A meeting of the ratepayers was held last week at Ballymoney to consider the desirability of lighting the town by electricity. It was decided to bring the matter before the Town Commissioners.

The Westinghouse System.—The Paper upon the above subject which was announced to be read by Mr. J. S. Hambird on Tuesday evening before the Society of Arts was, at the last moment, unavoidably postponed.

A Man Killed by Lightning.—A man named Roger Alston, a gardener's labourer, was struck dead by lightning while weeding in a garden during a thunderstorm on Wednesday afternoon at Longridge, near Preston.

Shanghai.—The French quarter at Shanghai is to be lit by the electric light after April 1st, 1891. Tenders must reach Shanghai before the end of next December. M. A. Servaut, 6, Rue de Braque, Paris, will furnish all particulars to those interested in the matter.

The late M. Lucien Gaulard.—The Italian Society of Electricians has opened a subscription for the purpose of erecting a memorial of the late M. Lucien Gaulard. Subscriptions will be received in Paris up to the end of May by MM. E. L. Naze et Cie, 6, Rue Franche-Comté.

Coastguard Stations and Telegraph Offices.—On Friday last, in reply to a question by Sir G. Baden-Powell in the House of Commons, Lord G. Hamilton said there were round the coast of the United Kingdom and Ireland 750 coastguard stations, of which 325 were within one mile of a postal telegraph office.

Bath.—We are glad to learn that, notwithstanding the fact, recently announced in our City Notes, that the Bath Electric Light Company had failed to raise the required capital in the locality, yet that owing to Mr. Massingham's energy and perseverance there is no probability of the scheme being allowed to fall through.

Woking.—A company is about to be formed for the purpose of supplying Woking, which at present is not even lighted with gas, with the electric light. The capital of the new company is to be £20,000, and a provisional agreement has already been entered into with Messrs. Renshaw, King and Co., of Staffordshire, to supply the light and all accessories.

Douglas.—The tender of the Manchester Edison-Swan Company has been accepted for the lighting of Castle Mona Pavilion, Douglas, Isle of Man. The work is to be finished by the middle of July. The installation will consist of four dynamos, two supplying twenty 3,000 candle-power arc lamps, and two supplying 600 incandescent lamps of 16 candle-power each.

Electric Traction on the Metropolitan Railway.—The Unopposed Bill Committee of the House of Commons has passed the Omnibus Bill of the Metropolitan Railway Company, which, among other powers, authorises the company to work their line by engines "propelled by electricity, or any other mechanical power, either in addition to or in substitution of steam power."

Bournemouth.—A movement is on foot for establishing a Polytechnic at Bournemouth to provide technical instruction and promote the study of science and art in that locality. Mr. Wm. McGregor, M.I.E.E., who is well known as a retired officer of the Indian Telegraph Service, and who has taken the project in hand, appeals for pecuniary or other help from all friends of technical education.

Bristol.—The Electrical Committee of the Town Council met on Tuesday last and had an interview with Mr. Preece, who has on one or two occasions been called in to report to the Bristol Council as to their taking steps with regard to electric lighting, and has advised the postponement of action. It is thought that now the time has arrived when more practical action may be taken.

Personal.—We have to announce the marriage on the 15th May, at Malta, of Captain Robert Greey, of the Eastern Telegraph Company's cable ship "Amber," to Antoinette Clarisse, second

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daughter of the Honorable Horatio J. Sprague, Esq., United States Consul at Gibraltar.—Mr. Melhuish, says the *Indian Engineer*, will succeed the late Mr. Johnston as electrician to the Government of India.

Electric Lighting in Surrey.—Mr. Stuart Rendell, M.P., is about to light Hatchlands, his country house, by electricity. The installation will consist of an 8 horse-power Marshall engine, Elwell-Parker dynamo, and 53 23L storage batteries of Drake and Gorham's latest type. The contract has been entrusted to Mr. A. A. Campbell Swinton. The installation will consist of about 150 16 candle-power incandescent lamps.

Frankfort-on-the-Maine Electro-Technical Institute.—The curriculum of the Frankfort Electro-Technical Institute for the term commencing this month has been issued. The major part of the lectures seem to be given by outside practical engineers, electricians, and manufacturers. There is also a special class on lightning conductors, a subject on which the minds of the German engineers, like our own, have of late been much exercised.

Exeter.—The Exeter Town Council has decided to grant permission to the Exeter Electric Light Company to erect 99 posts in positions to be approved by the City Surveyor for the necessary wires in a district covering the most important streets of the city. The permission was granted subject to a clause providing that, with the permission of the Council, the same posts might be used by any future applicant upon equitable terms.

Edison-Swan United Electric Light Company.—We are informed that the directors of this company have decided for the present to give up installation work, and that the company will devote itself entirely to the manufacture of lamps and first-class electrical fittings and instruments. Arrangements have been made with Messrs. Mather and Platt, of the Salford Iron Works, Manchester, to undertake the installation work which has heretofore been carried on by the Edison-Swan Company.

Bank Lighting.—Although there is so much central station work in progress we still find that the City banks are adopting the system of gas engines and accumulators which has been working so successfully for many years. Messrs. Drake and Gorham are now engaged in fitting up the Bank of Africa in Cannon-street, and we may mention that at the Union Bank of London, where there are over 300 lights, which have worked an average of 1,500 hours during the past year, there has never been a failure of the light, and we are informed that the working cost has come out considerably below the prices which are now quoted by the Supply Companies.

Temporary Lighting.—On Wednesday last Messrs. Woodhouse and Rawson (Limited) carried out a very successful example of this type of lighting at the Drapers' Hall (of the permanent lighting of which they have also the maintenance). The additional lights were placed in the courtyard, which was covered over with a canvas roof. In the centre, where the drapery was suspended from a centre ring, a large paper Japanese umbrella was hung, from the points of which were dropped 40 ten candle-power lamps, making a very effective electrolier. Below this was a large terra-cotta basin filled with beautiful exotics; the surrounding corridors were lit by suspended lamps in ornamental shades. Fifty-three 24L. E. P. S. cells were used with the usual satisfactory results.

Leeds.—At a meeting of the Electric Lighting Committee of the Leeds Corporation, held on Wednesday last, the borough engineer read a report relating to the work of the committee since 1883, when the Council granted a sum of money for electric lighting purposes. The report also contained a scheme for lighting the centre of the town by electricity. Mr. Hewson suggests that a central electric lighting station should be established on the piece of land known as the "Midden." At the outset he proposed that the plant, &c., should be provided to meet the requirements of that part of the town bounded by Leeds Bridge, North-street, Vicar-lane, and Park-row. The estimate of this would entail an expenditure of £61,000. Eventually provision could be made at the central station for the lighting of the whole of the borough by electricity. It was decided to print the report, and the committee adjourned its meeting till June 12th, in order that the members might have time to consider it.

The Visit of American Engineers.—The large party of Civil and Mechanical Engineers who are about to visit this country on their way to the Paris Exhibition, are expected to reach Liverpool on June 5th. After spending a week in visiting the great railway and industrial centres in Lancashire, Yorkshire, and the Midland Counties, they will arrive in London on the 12th June. On Thursday, the 13th, the whole of the gentlemen will be entertained by the members of the Institution of Civil Engineers at dinner, which will take place in the Guildhall of the City of London, by the express sanction of the Lord Mayor, Aldermen, and Common Council. During the following five or six days arrangements have been made for visits to various places of interest in London and the neighbourhood. Excursions up and down the River Thames will be organised, and various privileges will be granted in order to render the visit a memorable one. The Institution of Civil Engineers, with their well-known public spirit and hospitality, are actively exerting themselves in the matter.

Thunderstorms.—Severe thunderstorms occurred in various parts of the kingdom on Thursday last week. At Bradford there was a display of globular lightning; several houses were struck, and one was set on fire. At Walthamstow a porter was killed by lightning, and a woman was found dead in her house near Alfreton, having been struck by lightning. In Leicestershire three men took shelter in a hovel, which was struck, and one of them was killed. The old Abbey Gate House at Worksop was struck by lightning and greatly damaged. In Northamptonshire, Huntingdonshire, and Cambridgeshire much damage has been caused by thunderstorms. On Friday last the spire of Barrowden Church, near Stamford, was struck by lightning, and it is now in such an unsafe condition, about 20ft. being out of perpendicular, that it is considered dangerous to hold service in the church. In Huntingdonshire a fireball destroyed some farm buildings and stacks, and a number of horses and cattle in the district were killed by the lightning. From Germany it is reported that the powder magazine in the old fortress of Königstein has been struck by lightning and exploded, though without causing any loss of life.

Birmingham.—We understand, says the *Birmingham Daily Post*, that the negotiations between the General Purposes Committee of the Birmingham Corporation and Messrs. Chamberlain and Hookham have practically terminated, and that the issue of the Provisional Order promoted by the latter may be considered a certainty. The final form of the Order, as settled by the promoters in consultation with the Board of Trade and the Public Works Committee, limits the Order to a restricted area of the city, composed principally of Market Hall Ward. The promoters will be required to form a company with a capital of £50,000. There were till within the last few days some differences between the committee and the promoters with regard to a few of the details, but some of these have been arranged. On other points, including certain protective clauses usually required by the Corporation to be inserted in local Acts of Parliament, Messrs. Chamberlain and Hookham are willing to submit to the ordinary conditions. With regard to certain objections made to clauses in their own and in the London and other Provisional Orders, the promoters say that they will accept the general ruling of the Board of Trade. The promoters are prepared to proceed with the formation of a company the moment the confirmation of the Order takes place.

Stockport.—A meeting was held in Stockport on the 21st inst. to consider the proposal to form an electric lighting company in the town. Mr. J. S. Raworth, of the Anglo-American Brush Corporation, said if the proposed company put down a 5,000 or 6,000-light plant, electricity could be supplied at 3½d. per Board of Trade unit, and yield a return of 10 per cent.; with a less number of lights than this the price might be 4d. per unit. The capital of the company would be £10,000, but only about £8,500 would have to be spent at the start. Mr. J. J. Mann, the Manchester representative of the Anglo-American Brush Corporation, produced the plan of a suitable site for the central station in the Carrs, where 1,200 square yards of land was

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available. The Brush Company would undertake to construct the works and supply plant for 2,000 16 candle-power lamps, and hand the place over to the Stockport Company in working order, taking one-third of the payment in shares in the local company. He had been promised that at least 2,000 lights would be taken up. After some further remarks from gentlemen interested in the scheme the meeting terminated, the general opinion being that a larger station would pay better. Although no committee was formally elected, it is understood that the matter will be pushed forward and a board of provisional directors appointed to register a limited company to prosecute the scheme.

Major Marindin's Report.—On Thursday, the 23rd inst., Sir G. Campbell asked the President of the Board of Trade whether Mr. Calcraft's letter of May 18 regarding electric lighting in the Metropolis correctly expressed the present intention of the Board of Trade to adopt Major Marindin's proposals to set aside the provisions of the Act of Parliament of 1888 requiring the previous consent of the local authority in many cases; whether the Board of Trade had approved the proposal of Major Marindin that the mere objection by a local authority should not be considered sufficient to exclude any company unless the local authority was itself ready at once to undertake the supply of electricity and gave evidence of its intention to do so. Sir M. Hicks-Beach said, in reply, that Mr. Calcraft's letter correctly expressed the present intention of the Board of Trade. Major Marindin's report, however, did not go so far as was suggested in the second paragraph of the question. If in any case the consent of a local authority was dispensed with, the special report of the Board of Trade would be laid at the earliest possible moment before Parliament. It would not be consistent with the provisions of the Act of 1888 to insert in any Provisional Order any clause injuring or restricting the subsequent granting of a License or Provisional Order to the local authority or any other person within the same area.

The London County Council.—At the meeting of the London County Council last week the Highways Committee reported that they had had before them a notice by Messrs. Latimer Clark, Muirhead and Co., that, in pursuance of powers conferred on the St. James's and Pall Mall Electric Light Company, under License granted by the Board of Trade, they proposed to lay electric light mains and distributing boxes under certain thoroughfares in the parish of St. James, Westminster. The Vestry of St. James's had already consented to the laying of the mains referred to in the notice, and the Committee recommended that the consent of the Council be likewise given, on condition that the work should be carried out to the satisfaction of the proper authorities.—Mr. Haggis moved that the recommendation be approved. To this an amendment was proposed that the matter be referred back to the committee, it being urged that if the Council had the power they should only give their consent on conditions similar to those laid down by Major Marindin in his report on electric lighting in London. Mr. Haggis said the committee, of which he was the chairman, had before them the whole question of the electric lighting of the Metropolis. The recommendation in their report was, however, with reference to a company who had already had a License granted to them by the Board of Trade, and therefore that company had the right to lay the mains and boxes of which they had given notice to the Council. The amendment was agreed to.

Barnet.—At the last meeting of the Barnet Local Board a letter from Messrs. Ingledew, Ince and Co., solicitors to Mr. Joel, was read. The communication stated that while Mr. Joel desired to meet the Board in every reasonable respect, he reserved all his rights under his contract. The contract provided that he should apply for and obtain a License from the Board of Trade, and that the Local Board should assist him in doing so. The non-compliance of the Board with this provision would prevent Mr. Joel from putting the wires underground within twelve months, as required by Clause 5, and the Board must therefore release him from the obligation. Upon Mr. Joel's obtaining the license it would give him an interest extending over seven years in lieu of the three years provided by the Board, which would satisfy him for the large expense to which he had been put. Messrs. Ingledew also pointed out that the terms of the resolution passed on the 25th of April last (*The Electrician*, May 10th, p. 4) had been very prejudicial to Mr. Joel in his endeavour to make the lighting a success, and appeared to have been unjustified by the facts. Had the Board desired to defer for a time their consent to the application for a License, it might have been done without casting a stigma upon Mr. Joel, who now asked that the resolution should be rescinded. The Chairman (Mr. C. Stevens) said Messrs. Ingledew had just hit the point. The Board did not assist Mr. Joel to obtain a License for the very reason that it would give him seven years' tenure instead of three. Mr. James proposed that, as legal points were raised, they should, in the absence of their Clerk, refer the matter to the Lighting Committee, in conjunction with the Clerk. This was agreed to unanimously.

Conversazione of the Institution of Electrical Engineers.—The "conversazione" of the Institution of Electrical Engineers on Friday last was very largely attended, the guests of the President and Lady Thomson numbering some 735. Nearly all the leading Members of the Institution were present, and among the visitors were:—Sir Arthur Blackwood, K.C.B.; Sir James Crichton Browne, LL.D., F.R.S.S. (L. and E.); Sir Henry Doulton; Sir Thomas Sanderson; Sir John Coode, K.C.M.G.; Sir Juland Danvers, K.C.S.I.; General Eccles; Admiral Fitzroy; C.B.; Captain Creak, R.N.; Captain E. M. Shaw, C.B.; Col. Sir James Grant, C.B., F.R.S.; Captain Fisher, R.N.; Major Marindin, R.E.; Captain Boyle, Dr. G. C. Wallich; Prof. Frankland, F.R.S.; Dr. John Rae, D.C.L., F.R.S.; Dr. Gordon Hardie; Prof. Hering; Prof. H. Robinson; Dr. William Pole, F.R.S.S. (L. and E.); Dr. J. H. Gilbert, F.R.S.; Dr. W. H. Perkin, F.R.S.; Prof. W. H. Hudson, M.A.; Prof. H. E. Armstrong, F.R.S.; Dr. W. J. Russell, F.R.S.; Prof. James Groves, F.C.C.; Dr. Hugo Müller, F.R.S.; Prof. Hulme, F.R.S.; Prof. Meldola, F.R.S.; Prof. G. J. Romanes, LL.D., F.R.S.; Prof. Govier Seeley, F.R.S.; Prof. John Milne, F.R.S.; Prof. Hales, M.A.; Prof. G. T. Bonny, F.R.S.; Prof. W. Ramsay, F.R.S.; Dr. Bell, F.R.S.; Mr. J. G. Symons, F.R.S.; Sir Lowthian Bell, Bart., F.R.S.; Lord Sudely, F.R.S.; the Earl of Crawford and Balcarres, F.R.S.; Mr. Charles Cochrane, M.Inst.M.E.; Mr. William Anderson, M.Inst.C.E.; Prof. W. N. Shaw, M.A.; Mr. Ludwig Mond, F.C.S.; Mr. R. Brudenell Carter, F.R.C.S.; Mr. George Berkeley, M.Inst.C.E.; Mr. T. H. Blakesley, M.A.; Mr. Jacob Brett; Mr. H. J. Chaney; Mr. Charles Hawkesley; Prof. Huntingdon.

Halifax-Bermuda Cable.—In the House of Commons on Tuesday last Dr. Cameron asked the Secretary to the Treasury whether his attention had been called to the prospectus of the Halifax and Bermudas Cable Company, inviting subscriptions for £120,000 debentures, and setting forth "that the company has been incorporated for the purpose of carrying out a contract with Her Majesty's Government for laying a telegraphic cable between Halifax and Bermudas;" whether the sanction of the Treasury, as required by Article 11 of the Halifax and Bermudas cable contract, had been given to the transfer of the benefits of the contract from the International Cable Company to the new company; whether, as provided in Clause 14 of that contract, the International Cable Company, within seven days of the approval of the contract by the House, proved to the satisfaction of the Treasury that the £100,000 required "had been subscribed and fully paid up;" if not, whether under Clause 19 the contract had not "absolutely ceased and determined." In reply, Mr. Jackson stated that—(1) A conditional sanction to the transfer had been given; (2) the Treasury had modified Clause 14 in respect of the period within which it is to be proved that the capital has been subscribed and paid up, and had informed the company that they will accept such proof within one month from the date of the approval of the contract by the House of Commons. Under these circumstances the contract remained operative, one of its terms having been varied by agreement between the parties to it. In reply to further remarks by Dr. Cameron, Mr. Jackson said that if the contract varied in any essential point—as to the amount of the subsidy or the term of years it had to run—that would be contrary to the sanction given by the House, but he believed it was clearly understood that the Treasury had the power to vary the agreement.

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THE FUNCTION OF THE CONDENSER IN AN INDUCTION COIL.

BY DR. J. A. FLEMING, M.A.

Fizeau appears to have been the first* to suggest that the action of an induction coil employed for raising the electromotive force of a current would be increased by the employment of a condenser. The mode of use is as follows :—Let P be a primary circuit which takes current from a few cells of a battery, and let I be an interrupter in the primary circuit, either automatically worked by the magnetisation and demagnetisation of the iron core or by any other means. Let S be a secondary circuit of many more turns and high resistance. Under these circumstances each break of the primary current is accompanied by the production of an electromotive force in the secondary capable of producing a discharge across an air space in the secondary circuit. This electromotive force in the secondary is increased by any action tending to increase the suddenness of the stoppage of the primary current, and decreased by anything promoting a spark at the points of rupture of the primary circuit. Fizeau found that if a condenser, formed of alternate sheets of tinfoil and mica or paraffined paper in such fashion as to form a Leyden jar, has its two opposite coatings connected with the two extremities between which the rupture of the primary circuit takes place, then the electromotive force in the secondary circuit under the same circumstances is increased. In most current text-books and elsewhere this action is explained by saying that the extra current in the primary circuit, instead of being expended in making a spark at the contact points, darts into the condenser and hastens the decay of the primary current. This explanation as generally given is, however, very imperfect. A more complete examination of the nature of the condenser action has been given by Lord Rayleigh (*Phil. Mag.*, Vol. XXXIX., 1870, p. 428, *et seq.*). In the experiments there detailed a sewing needle was submitted to the magnetising action of an induced secondary current produced by the "break" of current in a primary circuit. In some previous experiments by the same writer (*Phil. Mag.*, July, 1869, p. 9) it had been shown that the magnetising effect of the secondary current was *cet par* proportional to the *initial* strength of the induced current, and that this initial strength was proportional to the quotient of M by N, or to the value of the ratio of the coefficient of mutual induction to the coefficient of self-induction of the secondary circuit. It was then found that the magnetising effect of the secondary current was greatly increased by connecting the plates of a condenser respectively to the two points between which the break of the primary circuit occurred. The complete investigation of the values of the induced and primary currents would under these conditions be a good deal more complicated than the investigation of the more simple case of discharge of a condenser through a single inductive circuit. We are here, however, only concerned with the first part of the electrical motion, the manner in which the currents wear down under the action of the resistances being of subordinate importance. It appears that when the electrical motion is decidedly of the oscillatory type the first few oscillations will take place almost uninfluenced by resistance, and on this supposition the calculation (following Lord Rayleigh) becomes remarkably simple.

Let L, M and N be the primary, mutual and secondary inductance, and let i and i' be the primary and secondary current strengths at any instant, and q and q' the quantities of electricity which have flowed through these circuits from the instant of beginning to reckon the time t,

then $$\frac{dq}{dt} = i \text{ and } \frac{dq'}{dt} = i';$$

and if we neglect resistance effects, as we can do at the instant after "breaking" the primary circuit, and call C the capacity of the condenser bridging across the "break" of the primary circuit, the equations giving the values of the primary and secondary current i and i' at the instant after breaking the primary circuit are—

$$L\frac{di}{dt} + M\frac{di'}{dt} + \frac{q}{C} = 0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$M\frac{di}{dt} + N\frac{di'}{dt} = 0 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Eliminating i' we have

$$\left(L - \frac{M^2}{N}\right)\frac{di}{dt} + \frac{q}{C} = 0 \quad . \quad . \quad . \quad . \quad . \quad (3)$$

(3) may be written

$$\left(L - \frac{M^2}{N}\right)\frac{d^2q}{dt^2} + \frac{q}{C} = 0 \quad . \quad . \quad . \quad . \quad . \quad (4)$$

A differential equation of this type always indicates an oscillatory motion. For consider the simple periodic function, $x = A \sin nt$, where $n = \frac{2\pi}{T}$, T being the periodic time of the motion, we have $\frac{dx}{dt} = nA\cos pt$, and $\frac{d^2x}{dt^2} = -n^2 A \sin pt$; hence, $\frac{d^2x}{dt^2} + n^2 x = 0$, and therefore $x = A \sin pt$ is a particular solution of this equation.

In the above differential equation n is seen to be 2π times the frequency of the oscillation.

Accordingly, equation (4) indicates an oscillation of the primary current, of which the periodic time is equal to

$$2\pi\sqrt{C\left(L - \frac{M^2}{N}\right)},$$

and this is the periodicity of the electric oscillation set up in the primary at the first instant after "break."

Equation (2) gives by integration the connection between i and i', and it is

$$Mi + Ni' = \text{constant} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which shows that the currents in the primary and secondary oscillate synchronously, the maximum of the one coinciding with the minimum of the other. Since i' is zero at the instant of "break," the constant in equation (5) must be equal to M I, where I is the current strength in the primary just before "breaking" primary circuit.

Accordingly, we have

$$i' = \frac{M}{N}(I - i),$$

so that when, after half an oscillation of the primary, i becomes equal to $-I$, we have

$$i' = 2\frac{M}{N}I \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

This equation gives us the *initial* value of the secondary current i' in terms of the value of the primary current just before the "break" when the condenser is used. It is easy to show (*see* Chrystal's article "Electricity," *Encyclopædia Britannica*, IX. Ed., p. 81) that, if the condenser is not used across the "break" of the primary, the initial value of the secondary current under the assumption of a perfectly sudden break is equal to $\frac{M}{N}I$; hence we see that the value of the secondary current, just immediately after the break of the primary, is *double* that which is there deduced as the value when the primary is simply suddenly stopped without the intervention of the condenser. Stripped of symbolism, what the above amounts to is this: if a condenser is inserted across the "break points" of a primary circuit, then on breaking the primary current continues to run on into the condenser for a little bit; it then *rebounds*, and is reversed in sign, retaining initially its full strength. The electromotive force set up in the secondary circuit is then the result of a stoppage of a primary current and its *immediate reversal* in direction, and this is equivalent to the removal of a certain number of lines of induction from the secondary circuit, and their immediate insertion into it in the opposite direction. Hence, when a condenser is so employed the inductive electromotive force in the secondary must be just double that which it would be if there were no such rebound of the primary. The con-

* *Comptes Rendus*, Vol. XXXVI., p. 418, 1853.

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denser acts by setting up electrical oscillations, and it does away with the spark, or largely diminishes it, in virtue of the fact that the condenser acts at the moment of "break" as if it were a shunt circuit of negative self-induction, only with this difference—that instead of dissipating energy like a conducting circuit it returns it again to the primary circuit in the form of a reversed current, and increases the total change of induction through the secondary circuit in the short interval of time immediately succeeding the "break."

Since the sparking distance of the secondary current depends on the initial electromotive force in the secondary—that is, on the maximum of the electromotive force—we see that the condenser so applied can greatly increase the sparking distance of the secondary discharge.

The action is essentially a phenomena of *resonance*. The condenser causes an elastic recoil in the current and enables the electro-kinetic energy of the steady primary current to be utilised in producing secondary electromotive force rather than suffer dissipation in the form of a contact spark. In order to be efficient in quenching spark the capacity of the condenser must be great enough to take up the full primary current, or to receive charge at a rate equal to the delivery of the full primary current for a time during which the contact or break points are separating to a distance too great to permit of much sparking jumping across. There is a certain capacity of condenser suitable for any given coil which produces the most beneficial result in quenching contact spark and lengthening secondary spark. The required capacity is best determined by trial, since the experimental data necessary to furnish the means to calculate it would be probably more difficult to obtain, owing to the fact that it will be determined by several variables, viz., the effective resistance and inductance of the primary circuit, the rate of breaking, and probably also by the amplitude of movement of the "break points." If the primary coil of an induction coil is traversed by an alternating current then the condenser as ordinarily used becomes superfluous. It will be remembered that the late Mr. Spottiswoode obtained secondary sparks of great magnitude from his large coil by so using the alternating current of a de Meritens machine.

REVIEWS.

The Telephone. By W. H. Preece, F.R.S., and J. Maier, Ph.D. (London: Whittaker and Co., 1889.)

The lack of a comprehensive treatise on the Telephone has long been apparent. In every other important branch of electro-technics we have writings—good, bad, and indifferent—enough and to spare, but with the exception of the usual "popular" handbooks, and one or two historical memoirs, surprisingly little has hitherto been written on the Telephone. Under these circumstances, the authors would be deserving of some gratitude had they given us an only moderately satisfactory treatise, but as a matter of fact there can be no hesitation in awarding to the volume before us higher praise than this. If not absolutely incapable of improvement, still we are honestly of opinion that this volume adequately fulfils its authors' intention, and will long remain the standard work upon the subject with which it deals.

In view of the fact to which allusion has just been made, that it is practically the first work of the kind, we shall proceed to give a somewhat full synopsis of the contents.

The first two chapters deal with the elementary theories of Sound and Speech and of Electro-magnetic Induction. The authors have succeeded in saying all that needs to be said (for the purpose in view) within less than 20 pages. We have then two chapters devoted to the discovery of the Bell Telephone and to the electrical properties of carbon under pressure. The credit of priority as regards the latter discovery is assigned to Edison, but stress is laid upon the fact that in practice Edison's "button of compressed carbon" has long since disappeared, every telephone transmitter in use to-day being essentially a Hughes Microphone. This is a fact with which electricians are perfectly familiar, but we could wish that it were better known to the general public. We have next a chapter on Theory, in which the famous experiments of Shelford Bidwell and of Stroh are recounted; but it is admitted that no complete and satisfactory theory either of transmitter or receiver has yet been advanced. Next we have three chapters devoted to the description of instruments. It is well known that since 1876 the Governments of the civilised world have derived no inconsiderable portion of their revenues from the granting of patent rights for the "invention" of various patterns of Bell receivers and carbon transmitters, and it will be conceded that in limiting their detailed description to only nine varieties of receivers and twenty-one transmitters the authors exhibit a commendable moderation. There is, in addition, an interesting chapter on "Special Telephones," describing some of those instruments which are not, properly speaking, either Bell receivers or carbon transmitters. Here we find the Edison "Electro-Motograph," Breguet's Mercury Telephone, the Photophone, the Radiophone, Preece's Thermo-Telephone, and Forbes's Thermal Transmitter. No mention is made of the interesting electrostatic receiver of Dolbear, or of the recent "water-jet" transmitterof Chichester Bell.*

The next chapter deals with "The Comparative Efficiency of some Transmitters." The authors observe, with much reason, that "Transmitters as well as receivers present the peculiarity that it is difficult to compare them with one another in the same exact manner that we compare, for instance, the electromotive forces of two batteries or the output of two dynamos." The authors think, however, that the importance of properly designing the induction coil has been too much overlooked. In some experiments carried out by the British Post Office, which have also been confirmed by the results arrived at by the Swiss Administration, it was found that the best effect was obtained with a coil constructed as follows:—Primary circuit, 180 to 185 windings of wire of ·6 millimetres (No. 23 B.W.G.) and ·5 ohm resistance; secondary circuit, 4,100—4,300 windings of wire ·15 millimetres diameter (No. 28 B.W.G.) and 250 ohms resistance. These experiments were made with a Blake Transmitter, and it does not follow that the same result would be attained with a transmitter, say, of the Hunnings type, where a much larger current passes in the primary.

The chapter on Telephone Wire is divided into two sections—(A) air lines, and (B) cables. It contains, amongst other things, an elementary discussion of the behaviour of iron and copper wires towards Telephonic currents, the various causes of disturbance on Telephone circuits, the methods of running "twisted" wires, the tests for copper wire employed by the British Post Office, and a Table of sags and stresses (on which subject there was an interesting and animated discussion in this journal about a year ago). One of the large iron frames used by the United Telephone Company on the London house-tops is shown in a full-page engraving, but we are a little surprised that the authors have nothing to say against the practice followed by this Company of employing double shackles where upright insulators would be both less costly and more efficient. Earth connections are mentioned here, but are condemned as "essentially bad" twenty-six pages later. The authors make no mention of the plan adopted at Richmond, Va., and some other places in the States (and very possibly elsewhere), where a common return wire is run upon many of the pole lines to which all circuits are joined up. This arrangement is not much more costly than the earth return, and it is said to have given excellent results in practice so long as care is taken to keep the return wire well insulated from earth. It is obvious, however, that it does not afford anything like as complete a cure for induction troubles as that given by a metallic loop.

Coming to the question of cables, reference is made to the practice introduced by Mr. Preece in 1878 of covering each wire separately with a coating of lead or tin-foil to act as an inductive shield; and it is pointed out that in order to be thoroughly effective the coatings must not only be very heavy, but must also be connected together and to earth. The authors state that "the efficiency of the lead covering is not due to the fact that it acts as a shield between one wire and another, but that

* See *The Electrician*, July 27, 1888, p. 375

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it forms a return circuit for the currents surrounding the prime wire." It is a little difficult to ascertain the exact meaning of this statement, since in general if there were no metallic shield there could be no such currents; but if the authors intend to deny the existence of the action termed "shielding," they are certainly in the wrong. By the aid of the formulæ developed by Dr. Fleming in *The Electrician* of January 11th and 18th, 1889, it would be easy in any given case to ascertain the necessary conditions for effective shielding, and hence to determine up to what point, if any, the game is worth the candle. The remainder of the chapter is devoted to underground cables, the methods of construction adopted by the chief makers being described in detail. The authors insist that lead-covered cables should never be buried in the soil without external protection.

Passing over a chapter on Auxiliary Apparatus—call-bells, lightning-protectors, &c.—and two chapters on the circuit connections of individual lines, we come to the most important section of the book, consisting of eight chapters on Telephone Exchanges. Here we may reasonably find some fault with the arrangement of the matter. Without any preliminary remarks upon the nature of an exchange service, we are plunged at once into a detailed description of the system adopted by the British Post Office, and it is not until we come to the following chapter on the German system that we are told that "all Telephone Exchanges are based upon one or other of two leading principles." These two principles are briefly—(1) The operator at the Exchange calls up the subscriber who has been asked for and informs him of the fact; (2) The first subscriber is merely "put through" upon the line asked for, and left to his own devices. The first system is obviously the more onerous for the Company, and requires a larger staff to work it properly; but this disadvantage is partially counterbalanced by the fact that it does not require a special ring-off signal, which is a great source of complexity in most systems of the second class. The authors have not attempted any more detailed classification; but we think it would not be altogether impossible to present the leading features of the chief systems in a schematic form, which would greatly facilitate their comparison. From a more purely technical point of view it would seem better to divide the systems broadly into "multiple" and non-multiple or simplex exchanges.

Amongst the latter class the system of the British Post Office, though not the cheapest, is probably unsurpassed in the efficiency of the service rendered. Space will not permit us to recount all the ingenious devices which render the working of this system as nearly perfection as any non-multiple system can become, but we may briefly indicate some of its chief peculiarities. Each subscriber is provided with a battery of two or three Daniell cells, *by which a constant current is maintained upon the line.* To communicate with the Exchange he merely lifts the telephone from its hook and finds himself at once *en rapport* with the operator. The operator receiving the number wanted calls the second subscriber. This is effected by means of a powerful battery, which actuates a relay connected with a local bell circuit at the subscribers' end. The relay is unable to respond to the weaker "permanent" current. At the close of the conversation the subscribers merely hang up their telephones, and the restoration of the permanent current gives a clearing-out signal in a quite unmistakable form. Metallic circuits are alone employed, and underground wires are used as far as possible.

Besides the advantage gained by the simplification of the subscribers' duties this system possesses several subsidiary advantages, such as the immediate detection of a fault on the line by the failure of the permanent current, convenience of daily testing, &c., but like every other non-multiple system it is ill adapted to the wants of a large exchange. Not more than fifty subscribers can be attended to by each operator; for any larger number the operators requiring cross-connections have to instruct each other by word of mouth, a condition which speedily imposes its own limit.

Passing on from the Post Office system, we naturally expect in a work of English origin to find some account of the much more extensive systems of the National, the Lancashire and Cheshire, and the United Telephone Companies. But this is not the authors' plan. We are taken all over Europe, and we visit America before we get back to our own country; and even then no systematic account of the development of the English Telephone Companies is anywhere attempted. The authors have little or nothing to say about the extension of inter-urban telephony in these islands, and indeed an ignoramus would probably gather from this book the idea that the telephone was in the hands of the Post Office to a very much larger extent than is really the case.

We next find a chapter on the German system, which is also non-multiple, and belongs to the authors' 2nd Class. Its most distinctive feature consists in the very excellent call and ring-off system. In practice the arrangement works as follows:—The subscriber first presses the call-button to ring up the exchange; this sends a positive current. He then unhooks the telephone and asks for the line wanted; on hearing that he is through he again presses the same button, but the telephone being now off the hook, the result is to send a *negative* current. This has no effect upon the polarised indicator at the Exchange, but it rings the subscriber's call-bell. When the conversation is finished the act of re-hanging the telephone *automatically* sends a positive current to line, which acts as a ring-off signal.

The French system, which is described in the next chapter, though still non-multiple, is somewhat more distinctive in character. Like the English Post Office system the speaking circuits are metallic throughout, but an earth connection is also made use of in order to obtain the advantage of a "direct call" between subscribers, similar in practice to that which has just been described. Two keys are provided, one of which rings up the exchange on the metallic circuit, while the other calls the subscriber (when the lines are "through") on the earth circuit. This arrangement offers great facilities for clearing-out signals, but it is a rather serious drawback that every subscriber has to be provided with no less than nine Leclanché cells.

The Paris Exchange numbers about 6,000 subscribers, distributed between twelve local exchanges, which are connected by 424 trunk lines. The details of the exchange connections are fully described.

The Swiss system is next described. It is also a non-multiple system, belonging to the authors' 1st Class, in which the subscriber wanted is called by the exchange operator. The tariff is probably the lowest in existence, being only £6 per annum. The public call-office system is well developed in this country, but non-subscribers are not allowed to speak over the trunk wires, with which most of the principal towns are now connected together.

So far we have been dealing with the methods employed by the official administrations of the European countries, but in the next chapter various non-multiple exchange systems are mentioned, most of which have found only a limited application. The "Law" system, which is first described, is in use in New York and in Brooklyn, and under a greatly improved form also in the Dundee district of the National Telephone Company. The distinctive feature of this system is the use of an independent calling circuit common to a large number of subscribers. The subscriber first switches his telephone into the call-wire circuit, and immediately gives his own number and that of the subscriber wanted. The operator, who is always listening, takes the peg attached to a flexible cord belonging to the number required and presses it against a plate connected with a battery, thus ringing that subscriber's bell; he then inserts the two pegs into a common bar, and the two subscribers are in communication as soon as the first subscriber has switched his telephone out of the call circuit. It will be seen that no indicator is required in this system, but on the other hand the operator has to receive the clearing-out signal by word of mouth, which may or may not be given by the subscriber. The great disadvantage of the system as originally designed lies, however, in the fact that the long looped call wire forming only one circuit was extremely liable to interruption. Mr. Mann, the engineer of the National Telephone Company's Dundee District, has effectually overcome this difficulty by making the connections of the wire in what an electric light engineer might describe as irregular series-parallel, so that omitting the earth connections, a diagram of the circuit looks like the trunk and branches of a

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tree. Mr. Mann has introduced other improvements in detail, and the working of the Dundee exchange leaves nothing to be desired—it is, in fact, one of the most satisfactory in the whole system of the National Company.

The Gilliland switch-board is still extensively used in America, although its design dates back to very early days. The lines are brought to a series of perpendicular bars or strips, and connection is made with other lines, or with the calling battery, by plugging in any one of a series of horizontal bars crossing at right angles. The details have been somewhat improved of late, but loose plug-boards are obviously doomed to disappear. The Williams spring switch-board is so far an improvement that connection is made by plugs attached to flexible cords, and consequently only one plug-hole is required for each subscriber. In working it closely resembles the method adopted by the Swiss Government. Messrs. Naylor Bros., of Berlin, have designed an ingenious though somewhat complex system; and lastly, there is the Chinnock system, which is used in five of the New York exchanges, and is much like the Gilliland in its general design, but instead of having the two sets of bars in one plane the horizontal bars lie underneath, thus making the arrangement much more compact.

The future of telephony in all large exchanges now admittedly rests with the "Multiple Switchboard." The authors do not mention—in fact, it is not generally known—that this principle was worked out in England by the engineers of the United Telephone Company well nigh simultaneously with its introduction in America by the Western Electric Company. At the date of the English patent of the American invention a multiple board was actually in process of construction at the Chancery-lane exchange, but no publication having been made the patent was unassailable. The principle of the multiple board is very simple; it consists in giving to each operator (as usual) only a limited number of subscribers to attend, but at the same time in placing within his immediate reach the means of coupling these subscribers' lines to any other line which enters the exchange; in fact, every subscriber's line after being taken to an annunciator at one section is carried on from section to section throughout the board, and in every section it is brought to a plughole whereby connections may be made in the usual way. This system, of course, involves an enormous multiplication of wires within the exchange, and much ingenuity has been expended in planning out clear and systematic methods of dealing with the wiring and making proper provision for testing the circuits and varying the connections.

One of the latest and most successful exchanges on this system in our own country is that of the National Telephone Company at Manchester, where several novel and highly valuable features have been introduced. This switchboard is built for no less than 4,200 subscribers, although only 1,600 are at present connected. The improvements introduced at Manchester have chiefly to do with the methods devised for readily testing or altering the connections of any given circuit, and in these important points the arrangements adopted would seem to approach perfection. At the same time the actual quantity of wire required for the connections has been considerably reduced. The extensive trunk wire system which radiates from Manchester has been dealt with—so far as the exchange service is concerned—in an ingenious and effective manner, but our space will not permit us to go into detail.

The question of "Intercommunication between two distant Telephonic Networks" occupies the next chapter. The problem to be solved is usually that of connecting two single wire (earth return) circuits at each end with the intermediate metallic circuit of the trunk line. This is effected by means of induction coils or translators. One of the earliest and most effective systems is that of Mr. Bennet. Slightly different arrangements have been devised by Nyström and Elsasser. The succeeding chapters deal with Public Telephone Stations, Automatic Connection Registers, and Multiplex and Long-Distance Telephony. Multiplex Telephony is at present of little value. It simply means using a double wire (1) as a complete metallic circuit, and (2) simultaneously as an earth circuit, with the two wires in parallel. (See *The Electrician*, November 12, 1886, p. 18). After describing the Van Ryssel-berghe system of Simultaneous Telegraphy and Telephony, the authors refer to some of the long-distance experiments which have been carried out in America, and they sum up the results as follows:—

"Telephonic communication, satisfactory even from a commercial point of view, has been carried on:

With a [copper] wire of 2·1 mm. [dia.] at a distance of				500	kilometres.
"	"	2·7	"	941	"
"	"	6·0	"	1,625	"

These experiments seem to show that the question of long-distance telephoning has nothing whatever to do with the kind of telephone used, the condition of the conductor alone being the decisive factor."

One or two chapters are devoted to a description of the various devices, most of them equally ingenious and intricate, which have been suggested with a view to the connection of several subscribers on one circuit. Of these, one of the best, and certainly the best known in this country, is that of Mr. Sinclair, of Glasgow. A chapter on "The Telephone Applied to the Telegraph Service," and one on "The Telephone as a Military Instrument," brings this valuable work to a close.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

"On the Security against Disturbance of Ships' Compasses by Electric Lighting Appliances."*

BY SIR WILLIAM THOMSON.

The danger to be avoided is sufficiently explained in the following short statement by Mr. William Bottomley, which appeared in the *Nautical Magazine* for December, 1885:—

"The following example of a case, which might occur in any large ship, will show the amount of error which may be produced on the compass" [by the electric lighting apparatus] "unless precautions are taken to guard against it.

"Suppose a main lead from the engine room to the fore part of the ship, to light up 100 lamps, is brought along the centre of the ship. It may be at a distance of 10 metres, or 33ft. from the standard compass, and will run almost underneath it. If we suppose that each lamp takes one ampere of current there will be a current of 100 amperes altogether in this lead. Now, the effect" [of an infinitely long straight current] "on the compass" [above it] "at a distance D in centimetres is given by the formula

$$F=\frac{2\times\frac{1}{10}C}{HD},$$

where C is the current in amperes and H is the horizontal magnetic force. In this case we have C=100 amperes and D=1,000 centimetres. Therefore,

$$F=\frac{20}{1{,}000\,H}=\frac{0{\cdot}02}{H}.$$

At Glasgow the horizontal force may be taken as 0·15 in C.-G.-S. units, therefore the effect on the compass will be $\frac{0{\cdot}02}{0{\cdot}15}=\frac{1}{7{\cdot}5}$. This will be expressed in degrees by multiplying by 57·3, the number of degrees in the radian, or angle subtended at the centre of a circle by an arc equal in length to the radius. Therefore, the amount of error produced by such a current on the compass will be $\frac{57{\cdot}3}{7{\cdot}5}=7{\cdot}6$ degrees.

"The foregoing refers to a single wire and a continuous current machine, but if an alternate-current machine is employed no effect will be produced on the compass even when the ship's side is used for the return. When a continuous-current machine is used, the danger of producing an error on the compass can be avoided by using two wires close to one another, but these wires should be well insulated from the ship's side. If in any way" [two points of] "one of the wires is brought in contact with the iron of the ship there may be no change observable in the lighting, but the current may produce as much error on the compass as it would if there was only a single wire.

"The following points should therefore be attended to in all case of lighting ships by electricity:—

"First.—With continuous current machines two wires, well insulated, should always be employed.

"Second.—The insulation of the wires should be tested periodically; if any connection with the iron of the ship is found the fault should at once be made right.

"Third.—When an alternate-current machine is used, a single

* Read before the Institution of Electrical Engineers.

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wire may be employed and the iron of the ship used to complete the current without producing any effect on the compass.

"What makes this question of the greatest importance is that the error may be produced without ever being detected by the officers of the ship. On board ship the errors of the compass are usually determined during the day, in the morning and afternoon, but the electric light is only used at night. The captain may therefore carefully determine his errors every day, and set his course quite correctly; but at night, when the electric light is turned on, the ship may be going several degrees off her proper course, although she is being correctly steered by the compass.

"In connection with the lighting of ships with electricity there is another point which should also be attended to—that is, the position of the dynamo. If it is placed near an iron bulkhead, the upper end of which is near the compass, the bulkhead may become magnetised by induction so powerfully that it will produce a considerable error on the compass."

The subject was also referred to in Mr. Bottomley's Paper on "The Magnetism of Ships and the Mariner's Compass," read before the Society of Arts, January 28th, 1886, and published in the *Journal* of the Society for February 5th, 1886. In the discussion which followed, and in which Captain Creak, of the Admiralty Compass Department, Mr. Alexander Siemens, and Dr. Hopkinson took part, it appeared that in three ships, lighted on the single-wire system with direct currents, small but not unimportant errors in the compass, due to the lighting currents, had been actually observed. Since that time several cases have been reported to me of large passenger ships, lighted with direct currents on the one-wire system, in which as much as 4deg. or 5deg. of error on the compass has been produced by the electric lighting.

In the latest of these cases, a few weeks ago, an error of 4deg. on the north course was found when the light was put on. The light was put on and off several times with the ship's head north, and every time the same error was produced.

The precautions for security which I have to suggest are—

1. The use of the two-wire method exclusively (unless, which is now rarely the case, alternate currents are used).

2. A differential galvanometer on the two mains for the lighting current to show approximate enough equality of the out-going and in-coming current. A rough and cheap instrument (on the old telegraph "detector" plan) would, I believe, suffice, and would be valuable for the electric lighting system (independently of the compass question) to give timely warning of any faults or accidental contacts or failures of insulation sufficient to cause any considerable difference in the strength of the currents carried by the two mains.

3. Care that there is not magnetic "leakage" from the dynamo (as practical men, guided by Faraday's ideas, theory, and language, have now taught the scientific world to call it) enough to produce any compass-disturbance of practical moment. Captain Creak, speaking at the end of 1885, in the Society of Arts discussion previously referred to, said that in one ship the direct compass-disturbance produced by the generating machine was "felt through a distance of 55ft.," and across iron bulkheads, and that it was perceptible also in other ships of the Royal Navy electrically lighted on the two-wire system.

My impression is that the improved dynamos now made have much less of magnetic leakage than those made prior to 1886, but we still want information as to their disturbing magnetic effect at such distances as have to be considered in connection with the compass question.

4. To ascertain that there is no perceptible compass-disturbance, or if there is any to test its amount, the compass should be observed while the current through the dynamo is started and stopped, either by starting and stopping the dynamo itself or by making and breaking the circuit of the field magnets. This should always be done before the electric light installation is taken over from the contractors. It is best and most easily done when the ship is in dock, or lying steadily at anchor. On no account ought it to be delayed, in a new ship, till she goes out for compass adjustment. A determination of the amounts of the disturbance, if any, for all courses of the ship can be made by aid of my deflector without moving the ship. But a sufficient practical test may be made by first observing the effect of starting and stopping the current on the compass as it stands; then adjusting a small magnet placed on, or supported a little above the glass of the bowl, to deflect the compass about 45deg. first on one side and then on the other side of its undisturbed position, and in each case observing the effect of starting and stopping the electric current. This effect ought not to be as much as 2deg. in any of the three cases.

5. A small electric lamp may safely (and with very great advantage in most cases of electrically lighted ships*) be used to light the compass. The effect, if any perceptible, of its current on the compass ought to be tested in the manner described in No. 4.

* Those who know the trouble of keeping the best of ordinary compass lamps alight, for the steering compass on the bridge of some of our cross Channel steamers in a winter gale, will appreciate this advantage.

DISCUSSION (AUTHORISED ABSTRACT).

In opening the discussion, Captain CREAK said he was glad Sir William recommended the two-wire system, for that in itself was a great safeguard against disturbance. So far as his own experience goes, most trouble arises from magnetic leakage due to the employment of machines having considerable external field and placing them in positions with respect to the iron of the ship that such field was directed towards the compass. In one case, H.M.S. "Northampton," where three such machines were used, an error of 11deg. was produced when all the machines were running, and three correction tables were necessary.

Mr. ALEX. SIEMENS, as an advocate of the single-wire system, thought it quite unnecessary to use two wires, for in all his experience, extending over many ships fitted on the single-wire system, only one instance had occurred in which complaint was made, and in this case the wiring was done before the position of the compass had been decided upon, the spot eventually chosen being in close proximity to the leads. As a proof that the single-wire system could be made satisfactory, he mentioned that his firm make inquiries on all vessels fitted by them every time they come into port, in order to ascertain whether any inconvenience arises from the electric lighting apparatus; but with the exception above quoted no complaint has been made.

Referring to Mr. Bottomley's letter mentioned in the Paper, Mr. SIEMENS said the screening effect of the decks had been entirely neglected in the calculations there given.

A second case of disturbance had come under his notice by his being asked to inspect a ship fitted by another firm, and the maximum deflections produced were ½ deg. and 1½ deg. on the standard and steering compasses respectively.

As regards the position of dynamos he had found no appreciable effect at distances greater than 50 feet.

Prof. G. FORBES, speaking of H.M.S. "Northampton," said that the dynamos referred to by Captain Creak were placed in an iron room, and still the disturbance produced was very serious. From an examination of machines of the type there employed he found that the leakage mainly comes from the parts of the yokes near their junction with the cores, but he had reason to believe that in the more modern machines the leakage has been considerably reduced.

Prof. JAMIESON mentioned the case of s.s. "Bombay," in which the steering compass was disturbed 9deg.; the fault was traced to a wire about 4ft. from the compass, and remedied by running a return wire.

Mr. RAWORTH, in corroborating Mr. Siemens with regard to the great convenience of the single-wire system, gave additional details respecting the second case mentioned by Mr. Siemens. The compass was influenced by either of two converging wires running along lower passages, according as the needle was parallel to one or to the other. On examining the decks the iron was found cut away between the wires and the needle, and the defect was remedied by enclosing the former in 3in. iron pipes.

Major CARDEW described his experience in lighting binnacles electrically, as suggested by Sir W. Thomson in his Note, and although he carefully twisted the leading wires together the filament seriously affected the compass reading.

Sir W. THOMSON, in reply, said that caution was necessary in arranging lamps for lighting compasses, and in answer to Prof. Forbes expressed an opinion that alternate currents if used in such lamps would not demagnetise the needles. Referring to the screening effect of decks, he pointed out that Capt. Creak's observations proved them to be of little use in neutralising the external field of dynamos, and to be efficient the iron required to be very thick. The decks may, however, considerably reduce the action of currents on the compasses, especially where the circuits are completed between two decks; but when the wires pass from one deck to another the screening effect is much reduced. Although the conductors in the single-wire system may be placed so as not to affect either one of the two compasses generally used, yet it is very difficult to arrange that neither are disturbed, and as any disagreement between the two (especially as the difference may vary with the portion of the ship being lighted) further complicates the navigation, Sir William felt sure it would be far the best plan to adopt the two-wire system in all cases.

The discussion on Mr. Mordey's Paper, on "Alternate Current Working,' was deferred till the next meeting, on May 30th.

THE AMALGAMATION OF THE TELEPHONE COMPANIES.

The following circular has been issued by the Directors of the United Telephone Company:—

"The directors of this company have been engaged for some time past in arranging a scheme for the amalgamation of the company with the National Telephone Company (Limited) and the Lancashire and Cheshire Telephonic Exchange Company (Limited), the intention being to form a new company which should acquire the property of the three companies, the new company issuing its shares to the latter on the basis of £15 to this company, £6 to the National Company, and £1. 11s. 6d. to the Lancashire and Cheshire Company, those figures representing the then market price of the shares. As, however, the Postmaster-General objects to the licenses held by the three companies being transferred to the proposed new company, the formation of that company must be abandoned.

"The amalgamation of the three companies is now intended to be effected by the purchase of two of them by the third, the latter

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company giving its shares as the purchase price. As the licenses held by the companies extend to the whole of the United Kingdom any one is sufficient to cover the business of all three companies when amalgamated.

"The purchasing company must obviously be the one whose shares are nearest to par in market price. The National Company most nearly complies with this condition, and it is therefore proposed that that company should absorb the Lancashire and Cheshire Company and this company.

"As, owing to legal considerations, the National Company's shares can only be taken at their par value, it is necessary to nominally reduce the figures originally proposed as the basis of the amalgamation, which will then stand as follows, viz. :—£12. 10s. for each share of this company, and £1. 6s. 3d. for each share of the Lancashire and Cheshire Company, the National Company's Ordinary Shares, representing the purchase price, being taken at par (£5).

"You will observe that the above amounts are simply the figures of the former arrangement reduced by one-sixth all round. The relative values of the interests of the shareholders of the three companies are therefore unaffected by the variation, the result being that the shares whilst of a rather less nominal amount will produce a corresponding higher rate of dividend, and may, therefore, be expected to command an equivalent price in the market.

"The new arrangement will take effect as from the 1st May inst., and power has been reserved to pay a dividend to the shareholders of this Company for the period ending April 30 last."

OBITUARY.

GASTON PLANTÉ.

It is with extreme regret that we have to record the death at the comparatively early age of 55 of M. Gaston Planté, which occurred in Paris on the 24th inst. For some years M. Planté's health has been in a precarious condition, and not long since he mentioned in a letter to ourselves that his sight had almost entirely failed him.

Gaston Planté was born at Orthez, in the Basses Pyrènées, on April 22, 1834. He received his scientific training at the Conservatoire des Arts et Metiers in Paris, where he afterwards obtained his first appointment as laboratory assistant to M. Ed. Becquerel. At a later date he entered the service of the eminent firm of Christofle et Cie. as chemist, and here he carried on the investigations into the nature of electric polarisation, which he had already commenced under Becquerel, and which subsequently led to his great discovery of the lead accumulator. M. Planté continued for many years to add to the number of cells in his possession; he studied their progressive formation with keen interest, and, as he had to rely chiefly upon the Bünsen battery for his charging current, the process was both tedious and costly. Many of his experiments on the discharge were of the most brilliant and even daring character, and there is no doubt that the weakness of sight to which we have referred was increased by, even if it was not altogether due to, repeated experiments of this description.

The results of these researches were from time to time communicated to the Académie des Sciences, or published in the various scientific periodicals. In 1879, just twenty years from the date of his first communication to the Academy, the whole of these Papers were issued in a collected form under the title of "Recherches sur L'Electricité." In this volume a vast number of experiments are described, many of which were carried out with a lead battery of no less than 800 elements. The "rheostatique machine," by means of which the potential could be still further raised, is one of M. Planté's most striking inventions, though it only occupies a few pages at the end of this book. By means of these appliances M. Planté was enabled to study the effects of currents of high potential and of discharges of great energy at a time when other *savants* were entirely dependent upon the limited possibilities of the primary battery. And at the very least it may be said that M. Planté made such good use of his opportunities that remarkably little has since been added to our knowledge in the class of work which he especially cultivated.

M. Planté was not one of those who seek to make their scientific discoveries a means of personal gain; indeed, so far as we are aware, he never at any time figured in the lists of the Patent Office. Yet he was by no means blind to the possibilities of the practical application of the lead battery, and amongst other suggestions for its use he referred at an early date to the electric light; although in an era before Swan and Edison were known, and when the dynamo was scarcely as yet a commercial machine, he was unable to foresee the full importance of the suggestion. Two years after the appearance of this volume, in October, 1881, the first actual commercial use of the accumulator took place, and—it is a fact perhaps not generally known—this was for train lighting upon the Brighton and South Coast Railway.

That same year M. Planté received the Diplome d'Honneur at the Paris Exhibition, and he was also made a Chevalier of the Lègion d'Honneur. A little later the Académie des Sciences conferred upon him the "Prix Lucaze," and he also received the Médaille d'Ampère from the Société de Encouragement pour l'Industrie Nationale. During the last few years of his life M. Planté devoted himself chiefly to the study of atmospheric electricity, which he did much to advance. About twelve months since he published a small volume of very great interest, under the title of "Phénomènes Électriques de l'Atmosphère," which was reviewed in *The Electrician* of August 3, 1888.

The honours which were showered upon M. Planté during the latter portion of his career did not induce him in any way to modify the quiet and retired life which he had led for so many years. Nearly his whole time was passed in his laboratory in the Rue des Tournelles, where, however, a kindly welcome was assured to every visitor, more especially to such as happened to take an interest in the pursuits in which his attention was absorbed. His modest and amiable character never failed to impress all with whom he came into contact, and his loss will bring a sense of keen regret to his numerous friends as well in this country as in his native land.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, May 31st.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "An Attempt to apply to Chemistry one of Newton's Principles." By Prof. DEMETRI MENDELEEF, D.Sc.

SATURDAY, June 1st.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "The Classification of the Sciences, Historical and Critical." By Prof. W. KNIGHT, LL.D.

MONDAY, June 3rd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Town Hall, Westminster. "The Forced Percolation of Water through Concrete." By HENRY FAIJA, M.I.C.E.

TUESDAY, June 4th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Some Recent Biological Discoveries." By Prof. E. RAY LANKESTER, M.A., F.R.S.

THURSDAY, June 6th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Chemical Affinity." By Prof. DEWAR, M.A., F.R.S.

CITY AND GUILDS OF LONDON INSTITUTE OLD STUDENTS' ASSOCIATION.

7:45 p.m. Ordinary General Meeting at the Central Institution. "The Economical Use of a Primary Battery based upon the Recovery of Zinc." By T. G. NICHOLSON.

CHEMICAL SOCIETY.

8 p.m. Ordinary Meeting. "Experimental Researches on the Periodic Law." By Dr. B. BRANNER. "The Amylodeatrin of W. Naejali." By H. T. BROWN and G. H. MORRIS. "The Determination of the Molecular Weights of the Carbohydrates." Part 2. By H. T. BROWN and G. H. MORRIS. "Researches on Silicon Compounds." Part 5. By Prof. EMERSON REYNOLDS, F.R.S. "The Isomerism of the Alkyl Dematives of Mixed Diazo-Amido Compounds." By Prof. MELDOLA and F. W. STREATFIELD. "The Atomic Weight of Zinc." By Dr. GLADSTONE and W. HIBBERT. "The Amount of Nitric Acid in the Rain Water at Rothampsted, with Notes on the Analysis of Rain Water." By R. WARRINGTON, F.R.S. "The Product of the Action of Sulphur on Resin." By G. H. MORRIS.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months.
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
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THE HALIFAX AND BERMUDAS CABLE.

Submarine Cables are by no means well represented in Parliament, and Members who meddle with them usually betray their extreme ignorance, or, as in a well-known instance, reckless hostility to the existing Cable Companies. But as regards the projected cable between Halifax (Nova Scotia) and Bermudas, the contract for which has lately been warmly discussed in the House of Commons, the critics are for once in a way entirely right and the promoters entirely wrong. Of the project, considered as a commercial undertaking, we will speak presently; but at the very outset the proceedings have taken such a questionable shape that the Government would have been justified, and perhaps well advised, if they had accepted Dr. CAMERON'S suggestion and cancelled the agreement altogether, as they had the power to do, instead of extending the term of grace in order to prevent the lapse of the contract. On the 9th inst. Parliament gave its sanction rather reluctantly to a subsidy being granted of £8,100 per annum for 20 years to the International Cable Company on their constructing a working cable between the above-named points, subject to capital being raised by the company amount-

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ing to £100,000 within seven days of the approval of the contract by Parliament. Neither of these conditions has been adhered to, the International Company having transferred the benefits of the cable contract to a new concern, the Halifax and Bermudas Cable Company (Limited), the time allowed for raising the capital being extended to 9th June. This has been done with the Treasury's sanction, and the natural result was that on Tuesday last some very strong protests were made against this mode of evading, or at all events seriously modifying, an agreement deliberately sanctioned by Parliament. We are inclined to agree with Dr. CAMERON that there is something farcical in gravely discussing the details of a contract the chief features of which can be altered by the Treasury the next day.

But we may leave the House of Commons to settle this technical objection with the Secretary to the Treasury as best it can. What we wish to direct attention to particularly is the curious circumstance that a transfer of interest was allowed to take place at the initial stage of the transaction without apparently arousing the least suspicion that the scheme was financially unsound. The transfer itself looks bad; the application for an extension of time to raise the capital still worse. And when we come to examine the prospectus of the new company, issued on the 24th inst., there appear good grounds for believing that Parliament might not have sanctioned the cable contract had that document been in the hands of Members on the 9th. From one point of view no doubt the Treasury made a good bargain, although, as was pointed out at the time, the subsidy is a large one for an outlay of what it is supposed will not exceed £100,000. Still, the Government avoid all the risk of the operation; they pay no subsidy when the cable is not working; and they reserve the right to send messages over the line at their own figure, which, following precedent, will probably be half the ordinary public rate. But on the other hand the guarantee that the cable will be maintained in working order even if successfully laid is remarkably slight, seeing that on the Board of Directors of the new Company there is not a single name known in the great cable-laying profession. Strange to say, moreover, the name of the firm that is to construct and submerge the cable is nowhere mentioned in the prospectus. If the object of the Government is, as we take it to be, to secure electrical communication for strategical purposes with one of their most important naval stations, the precautions taken for ensuring its efficiency are certainly of the slenderest character.

There are no doubt grave objections to the Government themselves undertaking a task of this kind, although it is one of national rather than of commercial importance. But the alternative course would have been to frankly place the matter in the hands of competent people whose reputation and standing would have insured the success of the operation and its permanent maintenance. The terms might have been different; but no terms whatever can be advantageous which may entice the nation into a position of false security as regards its naval and military stations. Where this cable is to be laid the waters are known to be deep and the current strong; and every appliance that experience and capital can command will probably be needed to keep the communication intact. In fact, it is simple folly for a company to undertake the maintenance of a submarine line which has not a sufficient mileage of cable to enable it to keep one or more repairing steamers. A single repair may be so costly as to be seriously embarrassing, because if it were necessary to charter a steamer in England to repair the Halifax-Bermuda cable the expense might soon run up to five or six thousand pounds, and it is quite evident that if, say, two repairs were required at intervals of a year or two the result would be disastrous. We fail to discover any elements entitled to command confidence on these essential points, either in the management of the new company or the manner in which its capital is being asked for.

One other point the Government ought to have taken more pains to inquire into than they appear to have done. The maintenance of the cable will depend largely upon its commercial prosperity, and any failure in this respect would be ill-repaid by impounding the Company's £15,000 caution-money. On a review of the conditions attached to this scheme we are satisfied that its prospects of commercial success are very remote indeed. The twenty years' subsidy of £8,100 per annum is to be used exclusively to provide interest and a sinking fund for the redemption of the capital. If, therefore, the traffic should prove insufficient to maintain and repair the cable, the subsidy will lapse, and cannot be utilised. And on a very liberal estimate we are unable to see where the traffic is to come from that will cover the working expenses and provide for contingencies; £5,000 a year probably will be the outside figure at which the traffic over such a line can be safely calculated upon, whilst the cost of the two stations could hardly be less than £4,000, and the London management £2,000, a year, making a total of £6,000 a year, exclusive of the cost of repairs, as to which further reference is made below. Unless we are greatly out in our reckoning the working loss is therefore certain to be considerable, while the shareholders will have to rely for their dividends solely on the subsidy, which will cease the moment anything happens to their cable. This is not a pleasant prospect for investors; but that is their affair. As regards the nation, however, the case is different and far more serious. The life of the Halifax and Bermudas cable, and the safety in time of war of a vital point in our circle of naval strongholds, are made to depend on the earnings of a line of cable which at best cannot be profitable, and the result may possibly be its speedy and ignominious abandonment.

LEGAL INTELLIGENCE.

King, Brown and Co. *v.* The Anglo-American Brush Electric Light Corporation (Limited).

Counsel were heard before Lord Trayner in the Court of Session on the 22nd inst., in the action for reduction of a patent right, brought at the instance of King, Brown and Co., Rosebank Electric Works, Edinburgh, against the Anglo-American Brush Electric Light Corporation (Limited). The evidence was reported in *The Electrician* when the case was before the Court last session. The pursuers were represented by Mr. A. Graham Murray, Mr. Dickson, and Mr. Daniell; and the defenders by the Dean of Faculty (Mr. J. B. Balfour, Q.C., M.P.), and Mr. Jameson.

Mr. GRAHAM MURRAY, for the pursuers, said he wished to recall to his Lordship the genesis of this action. Although he was there as pursuer he was at the same time in one sense really and honestly defending himself. This action was, so far as the Scottish Courts were concerned, the sequel to another action raised before his Lordship. In the condescendence in this action it was set out that the defenders had frequently threatened the pursuers with proceedings for infringement of their letters patent, and that in consequence the pursuers had lost orders and suffered damage. The previous action was brought by the pursuers against the defenders, and founded both upon common law and certain provisions of the recent Patent Act, was directed to have the Brush Company interdicted from publishing threats against the pursuers. The defenders put in defences, and said, "You cannot have the common law, and the provisions of the statute says you shall only have the right to bring the action provided the other party has not taken steps to put a stop to any infringement. His Lordship was with the pursuers in the view that they could raise the whole question of the patent in that action; but the Inner House were of opinion that a declarator of reduction of the patent should be brought. This was accordingly done, this action being raised. He was thus, though the pursuer, really defending himself and his legitimate business. The learned counsel then entered into a historical explanation of the progress of electric science, and the various systems of producing electricity. He explained the different shunt arrangements—shunt, series, and series-shunt, and by

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the use of models of dynamos made clear the uses and the value of these various systems. He explained the difference between potential and electromotive force. Coming to the question at issue, he said the reasons they asked for a reduction of the patent were these. They said, first of all, that the patent is bad upon the interpretation of it in respect of the commutators, because there was a claim for commutators in the final specification which is not covered by the provisional specification. They also said that taking the claims together on the commutators, his friends were in this difficult position, that either they were anticipated—being matter of common knowledge at the time, or else what little improvements there might be were such as were really not patentable. They also said that one part of the commutator claim was undoubtedly anticipated by Varley. They also said that the patent was bad in respect that the commutator claim was bad, because there had been the same sort of commutators in actual use before the patent, the use being both in Manchester and in Varley's own machine.

LORD TRAYNER: I understand your argument to be this. The provisional specification refers to a certain form and character of a commutator, but purely with regard to its form and the mode in which it may be, speaking quite popularly, easily repaired. The final claim (4) introduces an element of great importance in electrical science—that is to say, to cut off the current at a particular point where the cutting off is valuable to the work. That is not necessarily an implication involved in the original specification. The one is form, and the other is effect.

Mr. GRAHAM MURRAY said that was precisely his argument. In concluding that part of his argument Mr. Graham Murray said that if the patent was bad upon the commutators it was bad altogether—there was no patent at all; and therefore if he was right in this connection the case of the other side was at an end, no matter what decision there might be with regard to the question whether the real interest between them had anything to do with the commutators or not. Passing to what he said was the more interesting part of the case to them, namely, the question of series-shunt winding, counsel said his points were two in number—first, prior publication by Varley's specification, and secondly, prior use by Varley's machine. He would say that undoubtedly Brush's machine was a very great improvements but it was an improvement which for the practical purpose for which it was now used was not anticipated either by Brush or by Varley, whichever of them invented it. In fact, if he might be allowed to make use of a vulgar term, it was a gigantic "fluke," and the question was who "fluked" it first? (Laughter.)

LORD TRAYNER: What does that mean?

Mr. GRAHAM MURRAY said there was no word in the English language which conveyed the same meaning. There was not the slightest idea in Brush's case of the use to which that could be put, and the historical reason for that was, that at the time of both Varley's patent and Brush's patent the problem of incandescent lighting had not been solved, for the reason that there had not been discovered a suitable lamp owing to the want of suitable material. It was quite well-known that they could produce incandescence, but the difficulty was to find a suitable material that would resist the incandescence without being rapidly consumed in the process. That difficulty was eventually obviated. Having quoted from the specification, counsel said defender's witnesses wished to make out that the words "other applications of a permanent field" in the specification was a fair way of saying that one of the advantages they had in view was constant potential. Mr. Brush, however, was too honest for them on that point. He was rather an unfortunate witness, for when asked to explain the words "permanent field" in the specification, he said, "the words 'permanent field' refer to the permanent field of the machine, which exists both in the shunt-field arrangement and in the series-shunt field. These words do not mean an unvarying field, but they mean a permanent field of unvarying polarity." That there should be other useful applications of a permanent field besides electro-plating counsel did not deny, but he held that the securing of constant potential was not one of them. There was not, he maintained, any indication in the specification itself of their wishing to secure constant potential at all. Constant potential was not even the necessary outcome of series-shunt winding, but required a great deal more arrangement and a great deal more discovery. He admitted that a series-shunt machine could be constructed from Brush's description. If, however, they did construct such a machine, it would be an accident whether they got constant potential or not. The great advantage of the series-shunt arrangement—namely, the facility for getting constant potential with such a machine—was utterly unknown to Brush, as, he also admitted, it was unknown to Varley. The real merit of the invention had come by chance, and the question was which of these two men was the first to indicate the method of winding the machine, it being common ground that neither of them really knew the great effects to which that would lead. It had, he argued, been shown that Brush did arrange a machine by which, by accident, he discovered a method of winding which eventually led to an ending which he did not foresee. And why should not the same be the case with Varley's? He then proceeded to discuss the question whether that method of winding was disclosed in Varley's specification. He quoted the evidence of a number of witnesses with special reference to Varley's specification, and contended that he had shown that the description in Varley's specification was true of series-shunt. It was quite evident that it was not pure series winding which was suggested by Varley. First of all they cover two branches or circuits, and the same thing is quite true of pure shunt, because pure shunt would be inconsistent with the description on line 43, "When the electric light is being produced the greater portion of the electricity passes from the circuit of less resistance, which I term the electric light circuit, maintaining the magnetism of the magnets and producing the light." That would be absolutely untrue of a pure shunt arrangement, because the electricity of the electric circuit has nothing to do with the magnets and never went there.

LORD TRAYNER: The description by Varley is not consistent with either series or pure shunt for, I suppose, this reason, that this mode of producing his shunt is to wrap the soft iron magnets with two separate wires, one of larger resistance than the other. It is utterly absurd to describe either pure shunt or series-shunt.

Mr. GRAHAM MURRAY said that was so. Notice had been given them in the cross-examination of Mr. Imrie that the question of separate excitation would be raised, and he quoted evidence to show that Varley's patent was not separate excitation but series-shunt, the method being to wrap two wires round the magnets. At the time of the patent there were, as Varley said, several well-known ways of maintaining the magnetism of the magnets, but the method Varley preferred was not well known—that of wrapping two insulated wires round the magnets. The reason why Mr. Varley had not claimed the series-shunt patent was, as he himself explained, because he was afraid of coming into collision with his brother, who had made a disclosure. The actual fact was that that disclosure was not series-shunt but something resembling induction. Apart from that this arrangement of Varley's was a valuable one for another invention which had long gone into oblivion, but which at the time bulked very largely in Mr. Varley's mind, namely, a peculiar form of lamp. That lamp had not been a practical success. At the same time he wanted it to go, and it was necessary for its proper working that he should have that system of series-shunt winding. While the lamp had gone into oblivion the system of winding had come to be used for something of far greater importance. The lamp was an arc lamp with a motor, and the carbons were kept in proper position by motion in the lamps, and that lamp motion was worked by electricity, and the electricity devoted to the maintenance of that lamp motion was put into the circuit of greater resistance, or the shunt circuit. Mr. Swinburne said very clearly that none of the other systems of winding would have worked that lamp. It was quite impossible to reach the result of putting series-shunt out of the way by a process of destructive criticism, as had been attempted by his friends on the other side, and in which they had failed. They began with the idea that Varley was describing something, and if they followed his directions explicitly they arrived at series-shunt, for the very good reason that they could not arrive at anything else.

Mr. Graham Murray had not concluded his speech when the Court rose.

THURSDAY, MAY 23.

The hearing of counsel in this action was continued before Lord Trayner in the Court of Session on Thursday.

Mr. GRAHAM MURRAY (resuming his argument on behalf of the pursuers) took up the question of anticipation of Brush's patent by Varley's machine, made by Siebe and Gorman. There was no doubt that that machine had got two windings. There was no doubt that it had an appropriate commutator, and nobody could say that that machine could not be used in five minutes, if it were in working order, as a series-shunt machine. In fact, the whole thing was there. There was nothing wanting that was wanted in a series-shunt machine. The criticism of it by the other side was that the connections were all left disconnected—that was to say, the wires were broken off at the terminals, and as no person could have connected it properly, it was not a series-shunt machine. Using a model of the machine, he showed that that contention was absurd. The next thing that was quite clear about the machine was that it was perfectly proved that it was actually used. The eye-witnesses to the use of the machine were four in number—Gorman, Meyer, Garnish, and Varley himself. It was quite clear that machine was built upon that specification, and, therefore, if that machine was series-shunt surely that was much better evidence than any amount of criticism upon the specification could possibly be.

LORD TRAYNER: Strengthened by the fact that the man who wrote the specification, and had his machine constructed according to it, had constructed a machine which an apprentice boy on the same specification twenty years afterwards exactly copied.

Mr. GRAHAM MURRAY: Exactly so. Having read extracts from the evidence of Gorman, Meyer, and Garnish, from which it appeared that the machine had been used to produce light for the purpose of conducting experiments in a water-tank, Mr. Murray said that the result of the evidence of these three witnesses was this—that they remembered the machine being used. They remembered that the lamp had only one wire to it and only one wire away from it. They remembered also that it was noticed that the magnetism greatly increased when the lamp was lighted and decreased when the lamp was out. They remembered that the power of the magnetism did not disappear when the lamp was lighted. There was a considerable amount of magnetism in it, as evidenced by the sparking of the brushes. Taking that with the state of the machine itself, it seemed to the pursuers that that entirely excluded any idea of the machine being coupled in any but the way in which it would be the most natural to couple it in order to make it work as series-shunt. They had it distinctly said by Mr. Meyer that upon one occasion they used it without the fine wire being connected. When so using it as pure series it did not answer, and they used it another way; so that whatever the way was he took it as a way in which the fine wire winding was utilised, and that being so there was an end of pure series. Supposing it was used as pure shunt the same observation applied. What was the use of the thick wire? None. Next, they came to separate excitation. His lordship would remember that separate excitation of that machine was entirely excluded by the existing commutator, because they had all the bits of the commutator connected for series in one continuous electric circuit. Therefore, unless the commutator connections had been entirely altered they could not have worked that machine by separate excitation. Dealing with the allegation that the machine was double-shunt, counsel said nobody has yet suggested what conceivable use that double-shunt would be. He looked in vain in the proof for that. As a matter of fact, none of his learned friend's witnesses really suggested that it was double-shunt until they came to Prof.

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Perry. That was just an heroic effort on the part of Prof. Perry to try and get out of the dilemma he was in about what had been observed of that machine. He got out of it theoretically by suggesting an arrangement by which these particular things might have been observed which were observed, and yet that the machine should not be series-shunt wound; but then in order to do that he had to suggest a key which as a matter of fact did not exist. Counsel then referred to the testimony of Mr. Varley. Mr. Varley was of course in one sense an interested witness. It was not unnatural that he should have a very paternal pride in his own invention, and of course he had taken up very strong views about it. His lordship would no doubt see that Mr. Varley was speaking the truth. If Mr. Varley was speaking the truth there was an end of the whole matter. In his evidence he said, "I had a machine constructed in accordance with my specification; it was connected as a series-shunt machine as described in my specification." If that was true there was an end of saying that that machine was not series-wound.

LORD TRAYNER said that the machine itself, looked at, showed that it was series-shunt wound. That was to say, it had two wires of different resistances. There was no doubt about that But the question rather was whether it was so coupled up as to be used as a series-shunt machine, or whether it was so coupled as to be used otherwise. There was also the additional observation that a series machine and a shunt machine being known, the reason why two wires were put upon the magnets was for the purpose of trying something different from a separate shunt or a separate series.

Mr. GRAHAM MURRAY said that of course the far-reachingness of the invention was not seen, but so far as the invention consisted in merely trying the two things together it was not an unlikely thing for a man to do.

LORD TRAYNER: So far as the potentiality of the machine was concerned Mr. Varley and Mr. Brush were in *pari passu*.

Mr. GRAHAM MURRAY: Yes. There was, continued counsel, another thing that helped Mr. Varley, and that was the sketch produced by him at the proof of a machine constructed according to his specification. It was certainly a very good memorandum of how that particular machine was coupled. There was no doubt as to the authenticity of the sketch in Mr. Varley's book, and there was also no doubt of what the sketch meant. The sketch was originally done in pencil and it was inked over. The only thing that remained was whether the drawing then was a sufficient disclosure in law. In the first place he used it as being a very good commentary of what the specification truly meant. There was no doubt as to the disclosure so far as the specification was concerned; and if the only result of following the specification was to construct a machine such as they had there, there was an end of the case, because it was practically proved that such a machine would be constructed. But assuming that the specification itself would not lead you to construct that machine then he said there was such use as in terms of law is public use. Very little use would do to invalidate a patent, and in support of this he referred his lordship to the cases of Carpenter *v.* Smith and Stead *v.* Williams. The use of the machine in Siebe and Gorman's yard was clearly public use. Upon the grounds he had stated he submitted the patent of the defenders' was bad.

LORD TRAYNER said there was one point in the case he should like to hear Mr. Murray upon. Suppose Mr. Varley and Mr. Brush, in equal ignorance of the eventual use of that machine, had both invented a machine, either simultaneously or the one after the other, for the purpose, say, of electro-plating. Suppose, further, that two or three years thereafter it occurred to Mr. Brush that although he had not seen it before that was the very machine for incandescent light, and he then patented it. Did the existing machine for that new purpose give him a patent?

Mr. GRAHAM MURRAY: Certainly not.

LORD TRAYNER: Is it quite certain?

Mr. GRAHAM MURRAY replied that it was. In the case, for example, of a machine for flattening silk there might be a patent for that machine if it were employed for flattening iron; but certainly if a man took a machine by which electricity was produced he could not say, "Having used the production of electricity for one object I will now use the electricity which is so produced for another object, and by that means obtain a patent," there being no new invention. Of course he quite well saw that there might be patentable matter left for improvements even upon the series-shunt winding.

LORD TRAYNER: If there were an alteration of the machine its application to a new purpose of course is patentable; but taking the machine as it exists, was the mere application of it rather than the thing itself a patentable right?

Mr. GRAHAM MURRAY: I believe there is law upon it. I have no doubt about the fact.

LORD TRAYNER: I have an impression, but may be quite wrong, that if the application is a perfectly new idea, and one of great utility and merit, it might be patentable.

Mr. GRAHAM MURRAY said his point was that if it were the application of a machine he quite agreed. But then it was not the application of a machine, it was the application that was made by the machine of the electricity. He quite saw that if suddenly they could find out that that machine which created electricity could by doing something else make something else quite different, they might have a new patent.

LORD TRAYNER: As you turn the machine to a totally different use?

Mr. GRAHAM MURRAY said, Yes; that would be really using for the first time a certain mechanical arrangement to produce a new thing different from its original production. Of course his lordship saw that here electricity would be produced precisely in the same way, but simply turned to another purpose.

LORD TRAYNER: Perhaps that is the distinction.

This ended the case for the Pursuers.

(To be continued.)

LETTERS FOR LEARNERS AND UN-PROFESSIONAL READERS.

BY H. D. WILKINSON.

Section III.—Magnetic Fields of Coils and Solenoids.

(Continued from page 14.)

150. *Intensity of Field at any point on the Axis of a Solenoid.*—The results already derived will afford sufficient ground to work upon in order to show how the field at any point on the axis of a solenoid is determined. In the two expressions for the field at the centre and at either end, if we consider only those factors which alter in value according to the position of the point on the axis, we shall be able to trace the general law for any point. On examining these expressions we find that

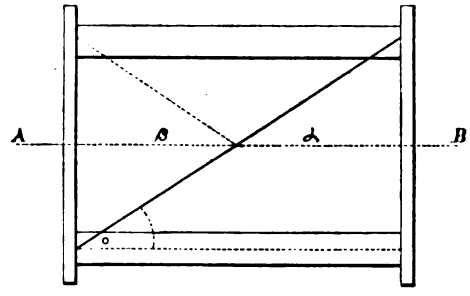


Fig. 153.

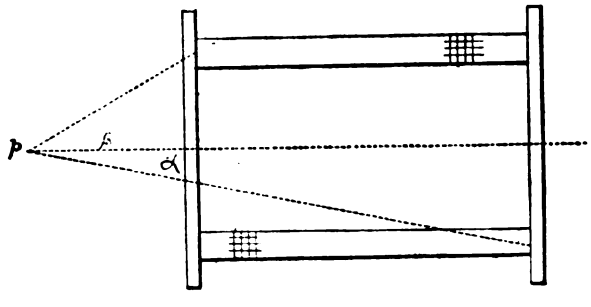
the factor $2\pi C_1$ occurs in both, and therefore the remaining factors depending on the position of the point considered are

$$\frac{2l}{D} \text{ at the centre,}$$

and

$$\frac{l}{R} \text{ at either end.}$$

Now the ratio of the length of the solenoid (l) to the diagonal (D) is the cosine of the angle (0) between them (Fig. 153), and it is evident that the angle 0 is equivalent to the angle α. Further, if a line is drawn from the centre to the other end of



Fig, 154.

the solenoid, as shown, it is evident that the included angle β is symmetrical with the angle α and equal to it.

We have, therefore,

$$\frac{2l}{D} = 2\cos\alpha = \cos\alpha + \cos\beta.$$

This is for the field at the centre of the coil; and now if we consider the field at one end we find in a similar manner that the ratio of l to R (Fig. 149) is the cosine of the angle between these lines. Generalising these results, it is not difficult to see that the field along the axis *within* the coil depends upon the sum of the cosines of the angles formed on each side of the point wherever that is situated on the axis. For instance, as the field is considered at points further away from the centre towards A (Fig. 153), the angle α becomes less and less while β becomes greater; and finally, when the point is taken at the end of the coil, as in Fig. 149, the angle β has increased to 90deg.

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where its cosine is zero, while α has become equal to the angle enclosed between the lines l and R, as we have seen above.

Replacing the constant factor $2\pi C_1$, and putting for C_1 its equivalent (Cn divided by l), we have the result that the intensity of field at any point on the axis *within* the coil is equal to

$$\frac{2\pi C n}{l}(\cos\alpha + \cos\beta) \text{ C.-G.-S. units.}$$

Now at the end of the coil the cosine of β is zero, and beyond this, viz., *outside* the coil, its cosine changes in sign. The field at any point outside the coil on its axis (such as at p, Fig. 154) is, therefore, proportional to the *difference* of the cosines of the two angles instead of their sum as above. The angle α in this figure is shown on the other side of the axis for convenience. It is evident that it is identically the same as when indicated above the axis in the same way at the point p. This may now be applied to some practical example. It is best to take some definite size of solenoid and calculate the intensity of field at various points along the axis, and from these results plot a curve showing the way in which the field varies. By this means an insight is obtained into the relative strength of field at various points on the axis of such a coil. Take a solenoid eight centimetres long and wound with 100 turns of wire, the mean radius of the coil so wound being one centimetre (Fig. 155). Say a current of 1·27

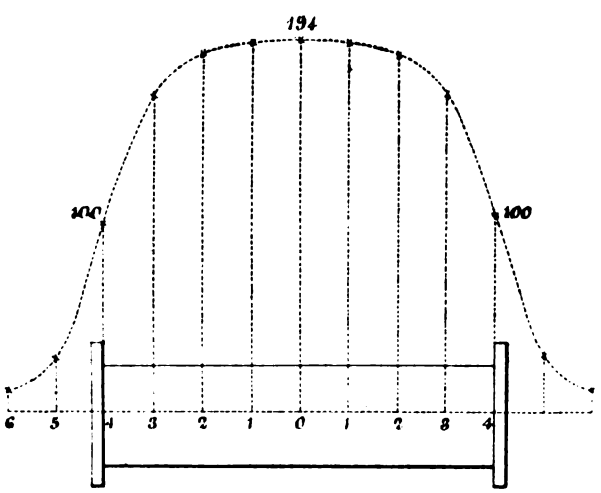

FIG. 155

amperes is passed through this winding, then the constant quantity

$$\frac{2\pi Cn}{l} = \frac{2\times 3{\cdot}1416\times 1{\cdot}27\times 100}{8} = 100$$

the current being expressed in C.-G.-S. units. The factors which vary according to the position of the points on the axis have now to be determined, and as the distribution of field is symmetrical on each side of the centre it is only necessary to make the calculations for one side. The angles themselves need not be determined, but simply their cosines, and this only involves in each case finding the value of the hypothenuse of a right angle triangle of which the other two sides are known. We have at the centre two equal angles, the cosine of each of which is

$$\frac{4}{\sqrt{4^2+1}} = \cdot 97,$$

the denominater being the hypothenuse, and found by extracting the root of the sum of the squares of the other two sides. At the centre of the coil the field is, therefore,

$$100\times 2\times \cdot 97 = 194 \text{ C.-G.-S. units.}$$

Now calculate the field at points on the axis one centimetre apart. At one centimetre distance from the centre the two angles are different, their cosines being found in the same way as the above, and added together, viz. :—

$$\frac{5}{\sqrt{26}} + \frac{3}{\sqrt{10}} = 1{\cdot}93.$$

The field to this point is, therefore,

$$100\times 1{\cdot}93 = 193 \text{ C.-G.-S. units.}$$

Similarly, at two centimetres from the centre the field is

$$100\left(\frac{6}{\sqrt{37}} + \frac{2}{\sqrt{5}}\right) = 188 \text{ C.-G.-S. units.}$$

At three centimetres the field, similarly calculated, is equal to 169 units. Now at four centimetres from the centre we arrive at the end of the coil where one angle becomes 90 deg. and its cosine nil, the cosine of the remaining angle being

$$\frac{8}{\sqrt{65}} = \cdot 99.$$

The field at the end of the coil is, therefore,

$$100\times \cdot 99 = 99 \text{ C.-G.-S units,}$$

or a little more than half that at the centre. It will be observed that the field diminishes very rapidly at this part of the axis. At five centimetres from the centre the point is outside the coil, and the difference of the cosines is therefore taken. The field is therefore

$$100\left(\frac{9}{\sqrt{82}} - \frac{1}{\sqrt{2}}\right) = 28 \text{ C.-G.-S. units.}$$

Similarly, at six centimetres from the centre the field is equal to

$$100\left(\frac{10}{\sqrt{101}} - \frac{2}{\sqrt{5}}\right) = 10 \text{ C.-G.-S. units.}$$

These values plotted give the curve shown in the figure, which therefore graphically represents the variation in intensity of field along the axis. It will also be noticed by the foregoing example that when we have a given strength of current per unit length of solenoid (Cn divided by l constant), the variation of field along the axis depends only upon the geometrical dimensions of the coil; that is, on the relation between the mean diameter and length of the solenoid, and not on its actual size as a whole. For example, the curve above plotted (Fig. 155) for a solenoid whose length is four times its mean diameter, will be precisely the same for solenoids of 2, 3, 10, or any number of times the actual size of the above, provided they have the same relation between length and diameter, and carry the same current per unit length, irrespective of the size of the wire composing the coil.

[With this section the Ninth Chapter of the present series is concluded. These chapters will be issued in volume form in a few months' time, when also the series will be resumed in the columns of this journal.—ED. *E.*]

ALTERNATE-CURRENT WORKING.*

BY W. M. MORDEY.

(Continued from page 67.)

PERIODICITY.

Some confusion is caused by the various ways in which rates of alternation are expressed, it being often quite uncertain whether periods or half-periods are referred to when "alternations" or "reversals" are spoken of. This confusion should be avoided by using the term "period," which has, I think, always been taken as expressing the complete cycle, or the changes undergone by a simple rectangle or elementary armature rotated from zero through a complete revolution in a simple magnetic field. To save confusion I always write it thus, $\curvearrowleft$; and I would suggest that this sign be used unless a better one be forthcoming, and that we agree to speak of periods, instead of alternations or reversals, and of periodicity instead of frequency or rates of alternation or of reversal.† Prof. Silvanus Thompson informs me that formerly a somewhat similar difficulty arose in regard to sound, and that confusion was avoided in the science of acoustics by giving the word

* Paper read before the Institution of Electrical Engineers on Thursday evening, May 23, 1889.

† This sign may be written something like, but rather larger than the algebraic sign ($\sim$) for "difference."

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"vibration" the definite meaning of the double motion which it now possesses, the French tuning-forks being stamped with the letters "V.D." (*vibration double*) after the number.

The subject of periodicity is becoming a very important one, for both commercial and scientific reasons. It urgently demands settlement in the interests of the whole industry. The very wide differences found in scientific opinion on this matter and in the practice of the various manufacturers must lead, and are indeed now leading, to much confusion and inconvenience. As things stand at present great uncertainty exists not only as to what rate is the best, but whether transformers, arc lamps, or other apparatus made by one maker, for a given E.M.F. or purpose, can be used on a circuit fed from an alternator constructed by another maker. It might be suggested that some joint action should be taken by manufacturers and others concerned in the direction of securing uniformity; but there are arguments against such a course, the principal one being that probably each maker believes he has good reasons for his own practice.

I venture to think there is no right or wrong periodicity What may be best for one set of conditions, or with one type of apparatus, may not be best for another. Or perhaps it would be more correct to say that there is a right periodicity, and that there are right and wrong apparatus; but this is rather a delicate subject.

The relative advantages of high or low periodicity must be considered as bearing on the five main divisions of apparatus used. Taking these in their natural order, they are :—

1. Prime Motors. | 3. Conductors.
2. Alternators. | 4. Transformers.

5. Lamps, &c.

Each of these divisions contains matter in relation to periodicity which in the near future will probably form the subject of many Papers, as the various subjects become better understood. I am not able to do more than touch briefly on each, in the hope that my remarks may lead to the expression of the views of others, and to some approach to uniformity.

1. *Prime Motors.*—At present questions affecting prime motors do not usually bear directly on the subject of periodicity. The only exception is the Parsons steam turbine, with which there seems to be no great difficulty in using a simple two-pole machine, thus making the number of revolutions and of periods the same. There may be found some want of flexibility as regards changes of size or output with such turbines, as, from the nature of the case, speed can only be varied by very large amounts. Thus, for instance, if 100 ∿ are required, there is no choice except between a two-pole machine at 6,000 revolutions per minute and a four-pole machine at 3,000 revolutions. This is, of course, on the assumption that the alternator is driven direct. If indirect driving is resorted to the difficulty is much reduced. It is unlikely, however, that the bearings of a steam turbine would work satisfacterily except with direct driving.

2. *Alternators.*—It is not allowable to doubt that the divergencies in periodicity found in practice are to a great extent the result of development and survival of what has been found to give the best results in each case; but from an examination of the machines in use it is very difficult to trace any common line on which action may be supposed to have taken place. It is true that the general tendency has been towards a reduction of the periodicity, but the causes which are responsible for that tendency are very obscure. I have seen large and small machines, made at the same time by one maker, in which the number of coils was the same, although one had to run at about 2,000 revolutions a minute and the other at less than half that rate of speed. At least one of these was wrong. For the purpose for which these machines were made the very high periodicity was almost unobjectionable in the small machine, but in the large ones it led to disaster.

It is a common mistake to suppose that high speed of driving, or high peripheral velocity, are necessarily connected with high periodicity and with large output. Of course any given machine, if run at a higher rate of speed than its normal one, must have a proportionately higher periodicity, but will not necessarily be capable of a greater output. It is quite possible to design a high-speed machine to give a low periodicity, and *vice versâ*. Perhaps the impression has arisen because with most alternators it is not possible or desirable to place the successive poles very close together on account of the magnetic leakage.

For machines with iron in the armatures it might be expected that the magnetic and electric losses, as well as the very considerable self-induction and consequent variations in the effective potential difference with changes of load, would lead to the reduction of the periodicity; but experience does not seem to have always led to this result. The lowest periodicity (42 with the Zipernowsky machine) and the highest (132 with the Westinghouse machine) are both found in alternators having iron cores. What is the reason of this great diversity? The machines have many points of resemblance, and yet one is run at more than three times the periodicity of the other. Not having seen the American machine I can offer no opinion based on personal observation; but of the Austrian alternator I can say that, in my opinion, it would not be advisable to increase the rate.

In a communication from Messrs. Ganz and Co., published a few days ago,* Mr. Zipernowsky says that the low periodicity used was chosen on principle to enable them to couple their dynamos parallel. He very cogently adds, in justification of this: "At present no practical electrician will hesitate to acknowledge the coupling of dynamos in parallel circuit to be a vital question of any parallel system of central-station distribution."

This bears out very completely my contention that the periodicity is governed in most cases by some special feature of the type of apparatus. Zipernowsky has had to go down to 42 ∿ to get his iron-cored alternators to synchronise, and for no other reason; for his statement is that synchronous action was "not a secondary result, but just the end we were aiming at," and he acknowledges that there are disadvantages connected with this low rate in other parts of the system.

But Westinghouse with 133 ∿ and Lowrie-Parker with 80—both having iron cores—can run parallel, the former with not less than half-load, the latter, as we now know, with any load; and I think I could run parallel without iron and at any load and periodicity, so that Mr. Zipernowsky's only reason fails to justify his action, except as regards his own particular apparatus.

Prof. Forbes recently stated that the exhaustive tests made in America with the Westinghouse apparatus had shown that there was no reason for reducing the rate of alternation, which is the highest now in use. This is very important, and it is to be hoped that some account will be given of the nature of the trials and of the results obtained. Mr. Ferranti, who at one time used very high rates, has for some time been using 80 ∿ at the Grosvenor Gallery, and has fixed 68 ∿ for the Deptford machines. I shall not be surprised to see him increase this before long.

In my own machine the periodicity is 100, which I believe is, on the whole, the best rate; but if it be required to do so for any special purpose there would not be much difficulty in changing it. The pole faces can be altered in number and in size by merely altering the pattern; the field winding, being in a single coil, would be equally simple and equally efficient for any periodicity. Even with a large number of poles placed close together, as would be required for a high rate, magnetic leakage would not increase. The size of the machine would not be sensibly affected. The armature would certainly be rather more costly for a high rate, as a greater number of coils would be required; but the efficiency, output, and regulating qualities would remain practically the same. Regarding this machine I think I may say that periodicity is not a question of the first importance. As far as I am concerned it is other divisions of the distributing apparatus that determine the rate at which it is desirable to work.

The bearing of the form and arrangement of any alternator on the best periodicity for that alternator is a very close one. The question cannot be settled on general principles.

I have referred elsewhere more fully to the conditions as they affect regulation under varying loads, parallel working, and other points in connection with alternators; and, as an appendix (*see* p. 20), I have quoted some observations made recently at the Institution of Civil Engineers during the discussion on Mr. Kapp's Paper, "On Alternate-Current Machinery," and not yet published.

I now pass on to the next division of the subject.

3. *Conductors.*—The choice of a suitable periodicity depends also to some extent upon the conditions as they affect the conductors.

The effect of rapid alternations in virtually increasing the resistance of conductors has been brought before us in Sir William Thomson's Presidential Address, and it becomes necessary to recognise clearly what practical limitations are imposed by this effect.

My attention was drawn to this matter two or three years ago, when I was called upon to examine and report upon an installation of about 1,000 100-volt lamps supplied directly by an alternator working at about 150 ∿. It was found that there was a very serious drop of potential in the conductors, and in consequence of this, the lamps could not be maintained at full power. On examining the circuit I found the cables were of ample size, and that the loss could not be explained in the usual way. As a result I came to the conclusion that it was to be accounted for only by some kind of inductional action, due to the alternating current, and I advised that a direct-current dynamo should be put down in place of the alternator. This was done, and with a perfectly satisfactory result. The lamps were for the first time run at their proper power, and no further trouble was experienced.

At that time I was, like most other electricians, a disbeliever in alternating currents, which I vaguely regarded as essentially unsatisfactory. I think there was a more substantial basis for this opinion than is now generally admitted. Alternating currents as

* *The Electrician*, May 10th, 1889, p. 16.

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then most often used were not satisfactory ; and if great care is not taken at the present time some of the old difficulties will be encountered, with the result of unnecessarily discrediting the transformer system of distribution.

From Sir William Thomson's Address, and from some further information he has kindly sent me, I have worked out and tabulated some figures showing what restrictions are imposed by the virtual increase of resistance of solid conductors with alternating currents, as bearing on the question of periodicity.

Sir William Thomson gives some figures for a periodicity of 80, to which I have added some columns giving diameter in inches, sectional area, and the current which the practicable sizes will carry, taken on the basis of 450 amperes per square inch, because that density gives *1 per cent. loss per mile* with 2,000 volts. It also gives about *1 per cent. loss per 100 yards* with 100 volts, or, more exactly, 1·15 per cent. I have also given the number of watts at 2,000 volts and at 100 volts for each size, to show the limits for ordinary primary and secondary working with this density. These figures are given for 80, for 100, and for 133 ∿, the diameters of conductors for the same percentage increase of virtual resistance over ohmic resistance being in the inverse ratio of the square roots of the periodicities.

TABLE I.—*Virtual Resistance, &c., of Conductors with Alternate Currents.*

Diameter.		Area.		Increase over Ordinary Resistance.	Current at 450 amps. per sq. in.	Watts at 2,000 volts.	Watts at 100 volts.	∿ per second.
MM.	Inch.	Sq. mm.	Sq. in.					
10	·3937	78·54	·122	Less than $\frac{1}{100}$ %	55	110,000	5,500	80
15	·5905	176·7	·274	2½ %	133	266,000	13,300	
20	·7874	314·16	·487	8 %	220	440,000	22,000	
25	·9842	490·8	·760	17½ %	...	...	...	
40	1·575	1,256	1·95	68 %	...	...	...	
[100	3·937	7,854	12·17	3·8 times	...	...	...	
1,000	39·39	785,400	1,217	35 times	...	...	...	
9	·3543	63·62	·098	Less than $\frac{1}{100}$ %	45	90,000	4,500	100
13·4	·5280	141·3	·218	2½ %	98·5	197,000	9,850	
18	·7086	254·4	·394	8 %	178	356,000	17,800	
22·4	·8826	394	·611	17½ %	...	...	...	
7·75	·3013	47·2	·071	Less than $\frac{1}{100}$ %	32	64,000	3,200	133
11·61	·4570	106	·164	2½ %	74	148,000	7,400	
15·5	·6102	189	·292	8 %	131·4	263,000	13,140	
19·36	·7622	294	·456	17½ %	...	...	...	

It will be seen that for 100 ∿, with wires of 9 millimetres, or ·35in. diameter, the increase over the ordinary resistance is almost imperceptible ; for a diameter of 13·4 millimetres, or ·53in., it is only 2½ per cent. ; while what may be considered a practical limit is reached at 18 millimetres, or nearly ¾in. At greater diameters the increase is prohibitive, and multiple conductors, tubes, or strips must be used. Probably an increase of 8 or 10 per cent. will be considered quite permissible. It sounds a good deal, but it must be remembered that it is only 8 or 10 per cent. of the 1 or 2 per cent. loss for which primary conductors are usually calculated.

Looking at the limitations as regards output, it may be said that for primary distribution, even at no higher tension than 2,000 volts, the virtual resistance effect is, if not quite unimportant, at any rate not very serious. A current of about 200 amperes may be conveyed without the effect showing itself to any very objectionable extent. There may be differences of opinion on the subject, but most people will agree that 300,000 or 400,000 watts is quite as much as should be supplied through any single conductor. In most cases, even at ordinary tensions, subdivision of the primary will be necessary or advisable before such a power is reached. With still higher pressure, of course, enormous powers can be dealt with without exceeding the permissible size of solid conductors. It is to be observed that there is nothing in this virtual resistance effect to necessitate the reduction of current by the employment of very high pressures.

It is only with the low-tension secondary conductors that this effect becomes in any way serious. With 100 volts the maximum load at this density that can be put on a single solid or stranded conductor is about 13,000 watts for 133 ∿, 18,000 for 100 ∿, and 22,000 watts for 80 ∿, unless much more than the 8 to 10 per cent. increase can be endured. This only means in large distribution work a subdivision of the primary and secondary feeding points in accordance with this limitation. The inconvenience has only to be recognised to be avoided. Fortunately it is not one that with ordinary care is likely to lead to any practical inconvenience. It exists with alternate currents, but it is a matter that the transformer system renders it very easy to avoid. Transformers lend themselves to subdivision of work, and with subdivision this difficulty does not exist.

It may be worth noting, in connection with this part of the subject, that the improvement in alternators, and the great ease with which they and their circuits can be worked and controlled, may lead to some revival of the practice of supplying direct from low-tension alternators. If this is done for any but very small installations it is evident that special precautions must be observed to avoid the difficulties which have been referred to.

One other remark on this subject. Very large conductors are to be avoided in the transformers as well as outside of them. This is only mentioned on account of its bearing on transformers for any very low tension work, such as electric jointing or welding, where one or two turns of secondary conductor is often sufficient.*

4. *Transformers.*—There appears to be a general belief that a high periodicity is best for transformers, and that this gives the greatest output, or—what amounts to the same thing—that with the same output in the two cases a higher efficiency is obtained when the periodicity is high than when it is low. This supposed fact has often been stated.

Prof. Forbes—who has, I believe, given much attention to the theory of this very difficult subject—contributed a Paper last year,† consisting of a mathematical examination, which is summarised and concluded by a statement that the periodicity may be diminished without loss of efficiency if the iron be increased ; the corollaries being, of course, that the periodicity may be increased without loss of efficiency if the iron be reduced, and that with any given transformer an increased periodicity results in increased efficiency for the same output, or in greater output with the same efficiency.

Prof. Forbes confirmed this view recently, in the discussion on a Paper by Mr. Kapp before the Institution of Civil Engineers, by pointing out that one of the reasons why in America they used a high periodicity was that "they wanted to get the greatest output from their plant, and transformers had to be increased in size in order to give the same output if they lowered the number of alternations."‡ And in his recent Paper on "Central Stations" before this Institution,§ Prof. Forbes reiterated this. He states that the contrary is "opposed alike to experience and theory. Westinghouse knows this. I am imformed Mr. Farranti knows it, and Mr. Zipernowski has told me that he finds it so."

Mr. Kapp, who works at 80 ∿, does not go so far as Prof. Forbes, for he thinks that on account of viscous hysteresis there must be a limit beyond which an increase becomes disadvantageous. He wisely adds that it is not possible to determine this limit on theoretical grounds.

On the other hand, it has been said that it is not necessary to increase the size of transformers even for very low periodicities, because, when the number of cycles is small, it is possible to work at a higher magnetic density.

I venture to question the accuracy of both these extreme views.

So far as transformers are concerned, and speaking only from experience, I think that high and low periodicities are both wrong, and that a medium rate is right. For a given output and efficiency not only must transformers be made large for low rates, they must

* The following particulars refer to conductors for primary circuits working at 2,000 volts, and show the sizes for various numbers of lamps giving a loss of 1 per cent. per mile run.

Data for copper conductors working with 2,000 volts pressure at the primary terminals of the transformers.

Transformers taken at 95 per cent. efficiency.

To allow 1 per cent. loss of pressure per mile of conductor, the primary current density should be 450 amperes per square inch.

Conductor for any given number of 60-watt lamps.

Sectional area in square inches = number of lamps × ·00007
Weight per mile, in lbs. = „ „ × 1·44
Resistance per mile in ohms = 630 ÷ number of lamps.

The following conductors comply with the above rule, and none of them is affected by the virtual resistance effect :—

Number of Lamps.	B.W.G. No.	Diameter.	Sectional Area.	Weight per Mile.	Resistance per Mile.
		Inch.	Sq. inch.	lbs.	Ohms.
100	13	·098	·007088	144	6·3658
200	10	·134	·014102	286	3·1890
300	8	·165	·02138	433	2·1102
400	6½	·191	·02865	578	1·5747
1,000	1	·300	·07065	1,433	0·6401

† "Formulæ for Converters," *Journal*, Vol. XVII., p. 153. This Paper was, no doubt, intended only as a mathematical investigation. It contains several assumptions that Prof. Forbes would probably not rely upon in practice.

‡ *Proc.* Institution of Civil Engineers, February 19, 1889.

§ *Journal*, XVIII., p. 194 (February 28, 1889).

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also be made large for high rates ; but between the two there will be found a periodicity giving the smallest size of transformer, or the greatest output, or the highest efficiency.

Fig. 2 illustrates this. It shows the rise of temperature of one of my transformers working respectively at 75, at 100, and at 125 ∿ per second. The primary and secondary virtual potential differences were measurably the same in all three cases, and in each case the same load was used, consisting of a certain number of glow lamps. The test was continued each time long enough for the transformer to attain its maximum temperature. This was taken by a sensitive thermometer, the bulb of which was placed directly on the iron, and covered by a packing of cotton waste to ensure that, as far as possible, at least the actual temperature of the iron should be indicated. Another similar thermometer was placed a few feet away to show the temperature of the room (which was fairly constant at about 60°F.).

The curves give the actual increments of temperature, which may be taken as some sort of measure of the relative efficiency attained. With any given output the same rise of temperature is, of course, always obtained with the same efficiency, quite apart from how that efficiency is made up. It will be observed that the lowest temperature or the highest efficiency is obtained at 100 ∿ ; that the efficiency is lower at 125, and lowest at 75 ∿.

On these lines I may suggest a method of arriving at the efficiency of transformers, which, though lacking in directness, is simple, and requires only ordinary appliances and facilities.

First run the transformer for some time in the usual way on incandescence lamps, the output being measured. It is not necessary to make any measurements of the primary. By means of

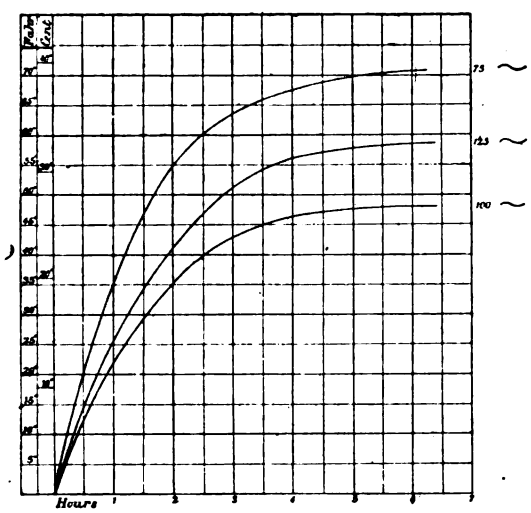

Fig. 2.—Rise of Temperature of Transformers at various Periodicities.

a thermometer find the rise of temperature of the transformer. Then, when the transformer has cooled down, send a continuous current through it, and measure the power in watts that raises the temperature of the whole transformer the same amount as when working with alternate currents. This takes some time to carry out, but it is accurate, and has the advantage that the lost power is measured in direct current quantities, about which there is no question ; while the power expended in the lamps, being in an inductionless circuit, is easily arrived at correctly. A wattmeter is the best instrument to use for the direct-current readings, as on account of the rise of resistance of the conductor (which is necessarily required to carry much more than the usual current), some adjustment is necessary in order to keep the power constant, and this adjustment is effected much more conveniently with a wattmeter in circuit than if an ammeter and a voltmeter are used.

5. *Lamps, &c.*—Under this head all apparatus for utilising or measuring alternate currents should be considered, so far as the action is affected by the periodicity. I must, however, confine myself to the lamps, which are the most important, and are the only apparatus as to which I can make any definite statements.

The Paper of Profs. Ayrton and Perry, read last year before the Physical Society,* showed that the efficiency of glow lamps is the same for both direct and alternating currents. The authors of that Paper did not directly allude to the question of relative efficiency with different periodicities, but they evidently had this point in their minds, as the periodicities used in the experiments appear to have been varied from 83 to 226 without showing any difference in efficiency. It may be taken, therefore, that no difference exists. Probably for very low periodicities this would not hold good, but for ordinary rates the question may be considered settled. At very low rates the temperature of the filament would follow to some extent the changes of the current, and would be affected both in life and in efficiency. I suppose that at ordinary rates there is no variation of temperature, the filament acting as a kind of thermal fly-wheel, maintaining its condition unchanged throughout the whole period. We all know for instance that, especially with low-resistance lamps, when the current is interrupted the time occupied in cooling down to blackness is quite appreciable. The periodicity at which the temperature begins to follow the variations of current is a point of some interest, and it is one that can be very easily investigated.

There is, as far as I am aware, no available evidence regarding the life of lamps with different rates, or even as to the relative life with direct and alternate currents. At one time it was considered that alternate currents would give better results than direct currents, because with the latter there was supposed to be some transference of the material of the filament in the direction of the current. Nothing has transpired to confirm or disprove this supposition, and, as the number of lamps now in use on each system is enormous, the very absence of evidence may be taken as affording a strong presumption in favour of the belief that the life of lamps is independent of whether the current is direct or alternating, and independent also of the periodicity, within practical limits.

Alternate-current arc lamps are not seriously affected by variations of periodicity within a fairly wide range. The feeding current of a parallel Brush alternate-current lamp remains sensibly constant between 75 and 125 ∿, but with the lower rate a slightly higher impedance or resistance is required to secure steadiness of the light.

Secondary E.M.F. Transformers.

The best potential difference to be used on transformer circuits has been a good deal discussed, especially with reference to the voltage of lamps. It is very desirable to arrive at some conclusions on this matter, not only as to glow lamps but as to the general question.

The balance of opinion—which is, however, not very decisive—appears to be in favour of using 50-volt rather than 100-volt lamps, so far as durability of the lamp is concerned. The stout low-tension filament should last longer than the finer one for high tension, because disintegration does not so soon reduce the cross-section to the breaking point. It is, however, not a question only of life, as the disintegration of the thick filament causes blackening of the globe ; and if it can be shown that this blackening, and the consequent lowering of the effective light, is more serious than in 100-volt lamps, then the advantage of slightly longer life will not of itself be sufficient to recommend 50-volt lamps in preference to others of higher voltage.

Of course the most serious objection to lowering the voltage is the increased cost of the secondary conductors. This is not important in small and very compact installations such as can be so readily supplied by transformers—for instance, in small shops and ordinary houses, where a separate transformer may be placed within a few yards of the lamps, and where the fall of potential is negligible ; but for larger work it is advisable to keep the potential difference high, as with direct currents, and for the additional reason that the use of very large alternate currents, with correspondingly large conductors, is accompanied by the inconveniences arising from the high virtual resistance already alluded to.

It is impossible, however, to choose an E.M.F. that will meet all requirements. For instance, high candle-power lamps are coming largely into use, and as this practice extends, higher E.M.F. will be demanded in order to keep down the diameter of the "stick."

But, on the other hand, lamps of small candle-power can be more easily made for low than for high voltage ; and as there is a growing tendency to use small candle-power lamps which in many situations give all the light that is required, this point should be kept in mind, especially as it is very probable that before long a demand will spring up for lamps of three or four candles. I know it will be said that it is easy to reduce the candle-power of ordinary lamps by inserting an impedance coil in the circuit. This is one of the many conveniences of transformer working, but it should not be resorted to for permanent purposes, as, however little power such a coil may absorb, lamps reduced in that way, being worked at less than their normal candle-power, are very inefficient.

Then there is another reason for sometimes preferring 50 volts to 100 volts that I should like to mention, and that is that alternate-current arc lamps do not require more than 50 volts terminal pressure. It may be expected that many such lamps will be used on transformers—for instance, at small business places, where perhaps the bulk of the lighting will be internal and by incandescent lamps, but where it will be convenient to have one or two arcs outside. We know that when arcs are used in parallel with incandescence lamps on direct-current circuits, it is necessary, in order to get

* *Jour.* Physical Society, Vol. IX., p. 208.

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the best results, to have 12 to 15 volts drop of pressure in a fixed resistance in series with each arc. Thus has arisen the custom of using 65 volts for mixed arc and glow lamp circuits, where the potential difference at the arc lamp terminals is reduced to about 50 volts by the insertion of such a resistance, the incandescent lamps, however, being made to work at 65 volts.

This is a very wasteful arrangement, but, apart from its wastefulness, 65 volts is a very inconvenient pressure both from the manufacturer's and the consumer's point of view. It does not lend itself to combination as does a pressure of 50 volts. Dynamos, lamps, or transformers for 65 volts cannot be used in pairs on 100-volt circuits as can such apparatus for 50 volts. It is an irregular and inconvenient pressure that is demanded by the necessities of direct currents, but that I am glad to be able to say need not be imported into alternate-current work.

This very serious loss can be almost entirely avoided with alternate-current arcs, as the necessary steadying effect is readily obtained by the use of an impedance coil, absorbing much less power than does a resistance; and as such arcs require only 35 to 40 volts between the carbons, instead of 45 to 50 with direct currents, it is sufficient to provide 50 volts potential difference between the secondary conductors.

But it may be said that as impedance coils absorb little power the arc lamps may be put on 100-volt circuits in parallel. This may be done without much objection so far as the lamp and impedance coil are concerned, but there is the drawback that the "plant-efficiency" of the transformer will then be low.

The output of a transformer is limited partly by the size of the conductor. The actual output of a 100-volt transformer supplying arcs through impedance coils will not be much more than the product of the current × 50 volts, while for the same output in watts on glow lamps it would only have to yield about half the current. Therefore we see that, although not inefficient, the maximum allowable output of a 100-volt transformer on parallel arc lamps is only about one-half of its ordinary maximum output.

It will be said that two arcs may be run in series on the 100-volt secondary. This is true, but two arcs are not always wanted; and, further, the working of two arcs (which must for this purpose be shunt or differential instead of simply series-wound) in series on a constant potential difference is the least satisfactory way of arranging arcs, whether for direct or alternate current, as in this way they affect one another the most, having neither the margin of controlling power, by current, which is provided in the parallel constant potential difference arrangement, nor by E.M.F., as in the series constant-current arrangement. Then, again, lamps so connected must be extinguished together, as no cut-out or switch can be used unless it is made to insert a resistance or impedance to take the place of the extinguished lamp.

On the whole, therefore, it is preferable to have 50-volt secondaries where arcs are to be used, or to adopt the intermediate plan of connecting the middle of the 100-volt secondary to a third terminal, using a third wire for any arcs or 50-volt lamps that may be required. It may be worth while to point out that the use of a third wire on transformer circuits may lead to difficulty if not carefully considered. With a single transformer it is as easy to use three or any other number of terminals for the lamps as it is to do so on a set of accumulators, and to get any corresponding potential difference. The various sections of the secondary may be unequally loaded by this arrangement, but the primary responds as a whole to the demand made upon it. If, however, instead of a single transformer two transformers are used, with their primaries and secondaries respectively in series, then the use of the three-wire principle is only possible when it is applied to both the primary and secondary circuits, unless the load on each of the two secondaries is always to be alike and the same, in which case, as scarcely need be said, there is no particular advantage in using three wires. If the loads are not equal on the two, then the primary of the least loaded transformer acts as an impedance coil to the other primary, and all power of self-regulation is lost. One remedy for this is to apply the three-wire principle to the primary as well as to the secondary; but this is a serious matter, and one that could only be undertaken where the whole service demanded it. Another plan is to have two mains for the primary and three for the secondary, and to join the primaries parallel, the secondaries being in series with the third wire at the middle terminal.

In cases where arcs have not to be used, and in the absence of any very strong evidence of any difference of life in favour of 50-volt lamps, I think it is best to use 50 volts for small separate installations, and 100 volts for larger ones; but it is evident from what has been said that there are so many points to consider that it is quite impossible to give any definite negative or affirmative reply to the question, "What is the best secondary E.M.F. to use?" Each case, or at least each class of cases, must be settled on its merits. If for general convenience any particular pressure is selected, it is obvious that it will have about equally strong arguments for and against it.

Alternate-Current Arcs.

Reverting to this subject, it is to be regretted that very little appears to be commonly known about A.C. arcs. I trust that in the discussion of this Paper some information may be furnished with regard to them.

As to the regulating mechanism of lamps, although some difficulties were encountered in modifying the Brush arc lamp for this work, the result has been perfectly satisfactory; the feeding range is very small—quite as small as with direct currents, and with no greater loss of power in the lamp-box. Some trouble was experienced in getting rid of noise and vibration in the coils and mechanism, but this has been completely overcome, the lamp itself being quite silent. This is readily proved by connecting the carbon-holders by a flexible wire and adjusting the current to the normal value, when it is found that there is no noise. An A.C. arc is not silent, as is well known, a distinct hum being set up, by which it is quite possible to ascertain the periodicity.

This humming noise, which can scarcely be expected to be overcome, renders A.C. arcs unsuited for general use indoors; but for outside illumination, and for such places as railway stations, they will certainly find a very extensive application.

I venture to think that the opinion so often expressed that A.C. arcs give much less light than those supplied with direct current is founded on a misunderstanding of the proper conditions. It is quite true that if two arcs are compared, supplied with the same amount of current, the direct-current lamp will prove the better one. This, I think, is because the basis of comparison is not right. In many cases the A.C. arcs are more efficient. They should be judged by the energy, and not only by the current. I have mentioned that an A.C. arc requires only 35 to 40 volts potential difference between the carbons, while a direct-current arc requires 45 to 50 volts. The mean may be taken at 37·5 volts and 47·5 volts respectively, and to expend the same energy in the two cases the current should therefore be in the inverse ratio of these values. Thus, an A.C. arc to give the same light and to absorb the same power as a 10-ampere direct-current arc should be made for 12·6 amperes.

In one respect A.C. arcs are inferior, and that is their power of directing the light downwards. They have no "crater," and therefore do not send the light down as do direct-current arcs. On this account it is advisable to use reflectors above them, unless they are suspended below and near a good reflecting ceiling or roof.

But even this drawback is counteracted in parallel work by their greater efficiency. On a 65-volt circuit with direct currents, as I mention elsewhere, there is a waste of 100 to 150 watts with a 10-ampere arc, and in the same proportion with other currents. This is a very serious proportion of the whole power, and it is only allowable to waste it because, as a light producer, the arc is so much more efficient than the incandescent lamp. Nevertheless, any means of avoiding the loss is to be welcomed, and with A.C. arcs it may be greatly reduced by the use of impedance coils, which, if properly designed, waste very little power, and have all the steadying effect of resistances.

(To be continued.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May* 18, 1889.

The final steps of the consolidation of the Edison electric light interests are now being taken, and an important circular has been issued by Mr. J. B. Williams, who at the present time is the President of the Edison General Electric Company. This Corporation acquires the stock of the Edison Electric Light Company, the Edison Machine Works, the Edison Lamp Company, and Bergman and Company, and it is also stated that arrangements are being made to acquire stock in the Sprague Company, should it be found desirable to do so. The Edison General Electric Company, whose incorporation under the laws of this State I noted recently, has a capital stock of $12,000,000. It is stated that the purchase of the various interests is equal to a capital sum on which the net earnings of the three manufacturing companies, as obtained from their books, show a net income of nearly 15 per cent. during the year ended November 1, 1888. In order to give greater security and stability to the project, dividends will only be paid at present on a part of the stock issued to the shareholders of the old concern, the dividends on the remainder being postponed until such time as at least 8 per cent. has been earned. Some

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idea of the basis of the deal may be formed from the statement that the shareholders of the Edison Electric Light Company will receive for each old share of $100 in the Electric Light Company $175 in the stock of the General Company, carrying full rights as to dividends, and $91 two-thirds in trust certificates of stock on which the dividends are deferred. Thus each of the stockholders will receive $266 two-thirds, making a total of $4,000,000 for the entire $1,500,000 of the old company. It is further stated, with regard to the General Company, that $2,666,650 of its stock will remain unissued for the present, available for future use. Hence it would appear that the Edison business as a going concern has been secured for $9,333,350. While details are not published as to the ownership of the stock of the manufacturing companies, it is generally understood that Mr. Edison has had a large interest in them, such, for example, as the Machine Works and the Lamp Company, both of which have, if I am not mistaken, been an ordinary co-partnership in the hands of five or six people. As I have before mentioned once or twice, this whole scheme of reorganisation has been carried through by Mr. Henry Villard, who in due course will become the president of the General Company, the present president, Mr. Williams, being his representative. It is also stated that the vice-president in the company will be Mr. J. H. Herrick, a well-known New York citizen.

Curiosity is naturally aroused as to what will become of the organisations which thus pass under the control of the General Company, and it may be stated at once that the intention for the present is to continue them as separate companies or establishments, each constituting a department of the business. While there will probably not be much change among the officers, a certain amount is to be looked for. It is very likely, for example, that Mr. E. H. Johnson, relieving himself of the responsibilities of active management of the whole of the Edison lighting business, will devote his attention to the interests of the Sprague Company, of which he is president, and whose business is growing so rapidly. It will be noticed that the Edison General Electric Company is likely to take a direct interest in the Sprague Company, and such a help will probably not be unwelcome, for the chief trouble nowadays is not to get the business, but to handle it when obtained. These new street railway contracts, involving a dozen miles of track and some 30 or 40 cars, with a big power station, require plenty of money for their execution, and thus involve heavy financing.

Quite a sensation has been caused in electrical circles here by the announcement that Mr. Edison has brought suit against two old and confidential associates for money which they are alleged to have received as his agents, but which, it is said, they have failed to pay over to him, or in regard to which he had been kept in ignorance. To summarise as briefly as possible the story told by Mr. Edison, it would appear that whilst he received only $500,000 for all his interest in the phonograph, his two confidential representatives received no less than $250,000, although his belief was that they were receiving but $75,000. He states that had he known that a secret agreement was to be carried out he would not have sold the stock of the Edison Phonograph Company at the price he did, but would have asked a higher amount of money for it. It might be added that of the $500,000 paid for the phonograph Mr. Edison did not receive the whole sum, as in accordance with his usual custom he distributed 1,750 shares of stock in the Phonograph Company among his assistants. Altogether it will be seen this is a pretty kettle of fish, and if report be true it does not go quite to the bottom of all the troubles concerning the development of the phonograph business. The gentlemen in question both deny very emphatically that they have in any way taken advantage of Mr. Edison while acting as his trusted and confidential agents, and that so far from being *beneficiaires* of Mr. Edison their relations with the distinguished electrician have resulted in financial loss to both.

Your paper, containing a keen editorial on the subway situation in this city, and discussing explosions, came to hand yesterday, and, as if to emphasise some of its remarks, we had another subway blow-up last night in Union-square, not far from the scene of the other explosion. Fortunately it occurred about 10:30 p.m., when there were very few vehicles or pedestrians in the vicinity, but it tore up 30 feet of the street, and the noise was heard for several blocks. This, of course, brings the matter to public attention again, and we are still without any adequate explanation of the trouble. At the present time there is not so much activity in pole cutting, but there is considerable dispute as to who shall pay for the work that has been done—whether it shall be the city or whether it shall be the companies whose property has thus been taken from them and destroyed. It is interesting to note that while this pole-cutting campaign has been going on the belief in the sincerity and public spirit of the Mayor has been considerably shaken, more, perhaps, by inference than by any direct proof of iniquity; in other words, he has had to make several appointments in city departments, and his selections have been so peculiarly bad, and are so suggestive of jobbery and truckling, that people are beginning to question whether the Mayor is such a remarkably virtuous and public-spirited individual after all.

Last week I mentioned the fact that Mr. Harold P. Brown had been surreptitiously purchasing Westinghouse alternating apparatus for the State, for the purpose of electrical execution. At that time there was nobody with sentence of death upon whom the new punishment could be inflicted, but since then a murderer has been condemned at Buffalo and the Judge has ordered that his execution shall take place by means of electricity on the 24th of next month at the Auburn prison. It will be remembered that the law establishing electrical execution was also very severe in it provisions against the publication of any details of the carrying out of the sentence, this restriction being directed against the sensationalism that often attends an execution and which places criminals before the lower members of the community almost in the light of heroes; but, as may be readily imagined, with a new method of execution to be tried, and with the invincible determination of the American newspapers to get the news, and all of it, it will be rather hard for the authorities to carry out the rule; in fact, it would be anything but wise at the outset to thrown any special mystery or obscurity around the new means of execution, for in the absence of definite details extraordinary exaggerations would get afloat, and the public mind would be worked up, and more harm than good would result. While very few electricians are found here in favour of using the electric current for capital purposes, we are all watching the results of this first use of it in an execution with considerable interest, and on the part of the public there is naturally a great deal of curiosity.

CORRESPONDENCE.

THUNDERSTORMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: From September, 1888, to March, 1889, I was staying in the plains of the Argentine Republic, not very far from Rosario, in the Province of Santa Fé. The weather was very exceptional, no less than 27 thunderstorms passing over the estancia where we lived in the period named. I was able, therefore, to make a few notes of a general nature on this subject.

(1.) *Is there "Sheet" Lightning?*—By climbing a ladder on to the roof of a large barn, I was able to watch the approach of each thunderstorm, the more readily as the plains were perfectly flat and devoid of trees. When the storm was very distant I noticed merely a silent lighting-up of the horizon—exactly like what is so often called "sheet" lightning in England. As it came nearer I could see part of or the whole of a vivid spark, as well as the lighting-up of the clouds, but still there was no sound. It was after the sparks had been in sight some time, and when the storm had come still nearer, that I could hear thunder following the spark.

After observing all these storms, and others that passed by us but were felt elsewhere, I came to the conclusion that I had never seen any "summer" or "sheet" lightning in England which did not resemble in every respect the appearance pre-

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sented by a *bonâ fide* "flash" occurring either very far off or behind very thick clouds; or, in other words, I came to the conclusion that I had no reason to assume that there is a "silent lightning discharge," the [noisy] spark discharge giving, under suitable conditions, all the appearances that had ever come under my observation.

(2.) *Discharges not Usually to Earth* (?).—During these thunderstorms the lightning would be for some hours almost continuous. Thus, one storm, January 6 and January 7, lasted nearly twelve hours. During the whole time the lightning was constant, and for some hours it was so continuous that one was able to go about in the yard, draw water from the well, fill vessels with water, and perform other operations requiring fairly continuous light; in fact, but for the trying effect on the eyes, I could have done some reading by the light.

Now there were 45 square miles of plain belonging to the estancia, and in all this space there were no trees, the most prominent objects being cattle and horses. There were round this estate posts of wood with wire.

During the whole 27 thunderstorms there was not one single case of an animal being struck, nor any sign of any single post having suffered. [Had the posts been of iron this would have been natural; but they were of wood.] Nor, as far as we ascertained, had any of our neighbours suffered from lightning.

I may add that my brother had lived for many years where there was no wire fencing, and that there, as also when within a fence, it was a rare occurrence for any animal to be struck.

The conclusion I was led towards was that nearly all the discharges were between cloud and cloud, not between cloud and earth. In a 12 hours' storm, for example, the discharges that took place somewhere over the estate were probably to be numbered in hundreds at least, so continuous was the flashing. If this were mainly the re-establishment of electrical equilibrium between earth and clouds, could the cattle on a flat, treeless plain have escaped?

Further, as far as one could judge by watching, the sparks did seem, as a rule, to be between one part of the sky and another. In all the 27 storms I observed this.

(3.) *Source of Electrical Disturbance* (?).—As far, then, as I could see, the discharges took place to a large extent up in the air between different clouds. The incessant flashing, moreover, seemed to point to a continuous exciting cause. Is it possible that it was the meeting of two currents of air that resulted both in the condensation shown in the heavy clouds and also in the electrical disturbance shown in the continuous flashes of lightning?

It seemed to be a general rule that a thunderstorm came up *against the* [*lower*] *wind*. Does not this suggest friction between two currents of air, a higher and a lower? Further, storms appeared to come back again after having passed, which again suggests irregularities in the wind currents.

It is of course an undoubted fact that in thunderstorms we have some lightning flashing to [or from] the earth. But I cannot help thinking that in these storms of the plains, at any rate, nearly all the discharges were from cloud to cloud.

Cheltenham, May 20, 1889. W. LARDEN.

MR. ATKINSON'S WORK ON "ELECTRIC LIGHTING."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has just been called to a notice served on Emmot and Co., of Manchester, by E. and F. N. Spon, of London, in regard to the sale of my work on electric lighting, claiming that the book "is an infringement upon the copyright of Prof. S. P. Thompson's "Dynamo-Electric Machinery," and that Prof. Thompson will take action in the matter if the sale is continued."

This is the same threat in more definite form made last fall when the book first appeared, to which I replied in the London *Electrician* of December 28, 1888, and the *New York Electrical Engineer* of January, 1889, stating fully and explicitly that while I had consulted various authors in the preparation of my book, and obtained information from every available source, no one could show a line improperly appropriated from any other writer.

I find nothing now to add to that communication, which covered all the details in regard to the preparation of the work which could be of any interest or importance. More than four months have elapsed since it appeared, and no one, so far as I am aware, has attempted to reply.

Among the various criticisms which have appeared it is strange that no discovery has been made of the plagiarism alleged by Prof. Thompson and his publishers. The fourth edition is now before the public, and I will kindly thank Prof. Thompson to point out anything in it wrongfully appropriated from any of his works.—Yours, &c., PHILIP ATKINSON,

May 10, 1889. 168, Randolph-street, Chicago, Ill., U.S.A.

A SEVERE TEST OF THE HOUSE-TO-HOUSE UNDERGROUND MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You may be interested to hear that at 3 a.m. last Sunday the West Middlesex Waterworks Company's main pipe, 5in. in diameter, at a pressure of 125lb., burst in Barkstone-gardens. The quantity of water that escaped was so great that it inundated the road and caused the ground to sink considerably. Their pipe was laid 3ft. 6in. below the road level, and our electric light supply mains were above their pipe about 2ft. 6in. One of our road boxes was exactly over the spot where the pipe burst, and as a large quantity of soil was washed away, our box was lowered a matter of about 18in. The pipes followed the box, giving only at the cork joints, without a single breakage. The pipes filled with water, which travelled along and trickled into the basements of one of the houses we are lighting. I am pleased, however, to advise you that the cable continued to run the lights satisfactorily.

I consider this a very severe test to any underground system of electric lighting; indeed, a lamp-post only ten yards distant fell down under the exceptional sinking of the, ground, and twelve cartloads of gravel had to be put on in order to bring the road to its proper level again. Our mains were raised as before without the slightest injury to the working within twenty-four hours of our hearing of the accident that had occurred.—Yours, &c., CHARLES J. HALL.

Kensington, May 28th.

P.S.—You are doubtless aware that under the system advocated by other companies in Kensington a breakdown under such circumstances would have been inevitable.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

May 9, 1869.

7,773. R. C. SAYER. Bristol. Improvements in means for actuating signals, switches, and gates on electric and other railways. Dated May 4, 1889. [Note: This No. cancels No. 3,487A in No. 18 of this Journal.]

7,774. R. C. SAYER. Bristol. Improvements in means for supplying electric current to road vehicles, boats, and the like. Dated 4th May, 1889. [Note: This No. cancels No. 3,487A in No. 18 of this Journal.]

7,780. R. MORRIS. London. An electrical firing apparatus for ordnance.

7,796. W. A. S. BENSON. London. Improvements in supporting electric conductors.

May 10, 1839.

7,856. W. C. JOHNSON and S. E. PHILLIPS. London. Improvements in electrical transformers.

7,860. S. PITT. London. Improvements in holders for electric incandescent lamps. (C. Lemon, New Zealand.)

May 11, 1889.

7,868. W. EMMOTT and W. ACKROYD. Halifax. Improvements in electric meters.

7,870. J. GOZO. London. An improved electric generator.

7,883. T. CUTTRISS. New Briggate, Leeds. Improvements in electro-motors and apparatus used therewith for dental and other purposes.

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7,894. L. B. ATKINSON. London. Improvements in the method of distributing electricity by means of alternating currents

7,895. L. B. ATKINSON. London. Improvements in dynamos, motors and motor-generators for use with alternating currents.

May 13, 1889.

7,919. R. T. GROCOTT. Longport. Improvements in apparatus for making certain articles of pottery-ware, such as electric lamp roses, switches, fuse blocks, and the like.

7,947. J. FARQUHARSON. London. Improved method of crossing the ends of drum armatures of dynamos.

May 14, 1889.

7,992. H. J. ALLISON. London. Improvements in combined telegraphy and telephony (J. H. Robertson, United States).

7,993. H. J. ALLISON. London. Improvements in exchange or central office systems as applied to telegraphs, especially autographic telegraphs (J. H. Robertson, United States).

8,030. M. E. UNGER. London. Improved automatic switch for charging electric accumulators and like purposes.

8,046. H. E. NEWTON. London. Improvements in electrical fire alarms (W. Birchall, Victoria).

8,053. O. IMRAY. London. Improvements in electrical signalling apparatus (A. W. Jones, B. F. Jones, and E. L. Martin, United States).

May 15, 1889.

8,070. A. R. BENNETT. Glasgow. Improvements in telephonic switching apparatus.

8,113. H. E. JOËL and J. S. CASSAL. London. Improvements in or applicable to electrical cells or batteries.

8,115. W. H. SNELL. London. Improvements in the thermo-magnetic generation of electric currents and in apparatus therefor.

May 16, 1889.

8,143. P. JOLIN. Bristol. Improvements in instruments for measuring electric currents.

8,157. L. SELLNER. London. Improvements in switches for electric signalling apparatus.

May 17, 1889.

8,213. W. LOWRIE and C. J. HALL. London. Improvements relating to the method and means employed for coupling alternating-current dynamo machines in synchronal relation and to the control of motive power engines used for driving the same.

May 20, 1889.

8,360. F. A. HOLCOMB. London. Improvements in apparatus relating to telephone systems.

SPECIFICATIONS PUBLISHED.

1888.

8,809. LAKE (Bergmann). Electric switches. (Price 8d.)

8,905. LAHOUSSE and Co. and COLLÉ. Electric batteries. (Price 8d.)

5,811. CROMPTON AND SWINBURNE. Generating, &c., electric power. (Price 8d.)

7,408. BOULT (Manet and another). Electrical fuses for firing blast holes, &c. (Price 6d.)

7,523. HOUGHTON. Electric lighting. (Price 8d.)

8,765. ROWBOTHAM and FOX. Electric lamps. (Price 8d.)

9,405. YORKE. Charging electrical accumulators. (Price 6d.)

9,487. RAWSON and WHITE. Electrical instruments. (Price 8d.)

9,672. LOWREY and Others. Dynamo electric machines, &c. (Price 11d.)

9,854. BRISTOL. Secondary batteries. (Price 8d.)

18,091. ALDRED. Electro-motors. (Price 8d.)

1889.

2,071. FERDINAND. Electric systems. (Price 8d.)

2,406. ROPER. Electric arc lamps. (Price 6.)

2,952 LAKE (Dressler). Electric relay apparatus. (Price 11d.)

3,350. Sir C. S. FORBES. Measuring electric currents. (Price 8d.)

4,722. LAKE (Griggs). Electric conductors. (Price 8d.)

4,800. LAKE (Brooks). Electric conductors. (Price 6d.)

5,095. HASLAM. Secondary batteries. (Price 6d.)

5,612. LAKE (Rice). Distributing electric currents. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Submarine Cables Trust.

The eighteenth ordinary annual meeting of the certificate holders in the Submarine Cables Trust was held at the offices of the Trust, Winchester House, Old Broad-street, on Friday, the 24th inst., Sir John Pender presiding.

The SECRETARY (Mr. Lewis Wells) having read the notice calling the meeting,

The CHAIRMAN said: Our revenue for the past financial year amounted to £19,118, as compared with £17,948 in 1888. As mentioned at the last meeting, the certificate holders for the two previous years received payment of their coupons at the rate of 4½ per cent. For the year ending April, 1889, the accounts of which are now submitted, they have had a return of 5⅝ per cent., and if we should not be disappointed in our estimate of revenue for the current year we hope to pay the full 6 per cent. The coupons are, as you know, cumulative, and we are now one coupon in arrear. We can only clear this off when our revenue exceeds the amount required to cover expenses and the two half-yearly coupons, together 6 per cent. For the past year our investment in Anglo-American stock has yielded us a dividend equal to £2. 8s. 10d. per cent., as against £2. 1s. 4d. per cent. in 1888, and if the Company should pay only 2½ per cent. for 1889, this will give the Trust a return of £3. 17s. on its investment. Having so large an interest in the Anglo-American stock, it is satisfactory to remark the improvement in the position of the Company. It is hoped that the trans-Atlantic traffic will grow at the 1s. rate, so as to render unnecessary any increase of tariff. Our other investments call for no special observations. We expect to be in a position to make a payment of £2. 10s. on account of the outstanding coupon on October 15th, and to pay the balance of 10s. a month later. We can only make these payments as the money comes in from our investments. I can only say that, being very intimately connected with the various telegraph companies, our prospects at the present moment are very satisfactory indeed. With improving trade there is generally an improvement in telegraphic traffic, and especially I think I may say that there is a marked advance in the traffic in those companies in which this Trust is interested. He concluded by formally moving the adoption of the report and accounts.

The MARQUIS OF TWEEDDALE seconded the resolution, which was unanimously adopted.

Mr. LAMONT moved, and Mr. PAYNE seconded, the reappointment of the auditors, Messrs. John G. Griffiths and John Gane.

The motion having been agreed to, a vote of thanks was passed to the Chairman, which concluded the business.

The Submarine Telegraph Company.

An extraordinary general meeting of this Company was held on Tuesday, at the offices, 2, Throgmorton-avenue, London-wall, under the presidency of Sir J. Goldsmid, Bart., M.P.

The SECRETARY (Mr. S. M. Clare) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, you will be surprised that we have called you together again, but the reason is very simple. You are aware that we have been a chartered company, and the proceedings for a chartered company are not exactly the same as for a company which is established under the ordinary company law. We thought if we passed the resolution which is suitable for a chartered company to pass, appointing liquidators and authorising a liquidation, that that would be sufficient, but as we were also registered under the Companies' Clauses Act the solicitor to the Post Office has been of opinion that it was desirable that the resolution should be passed under the Companies' Clauses Act in addition to the resolution which we passed as a chartered company. Consequently we have called you together to-day, and we shall have to call you together again, to confirm the resolution I am about to submit to you. The object of the present meeting is therefore very simple, and Mr. Campbell, our solicitor, has put it in legal form. Perhaps you would like me to read it to you. It is as follows:—

"The Submarine Telegraph Company between Great Britain and the Continent of Europe was incorporated by Royal Charter, with a deed of settlement (the charter is still in force). The Company was also registered (some years ago) under the Joint-Stock Companies' Act, but without Articles of Association, and under the Act the deed of settlement became the Articles of Association. The deed of settlement provides a certain mode of proceeding for winding up the Company, and in conformity with this resolutions were passed on the 25th day of March, 1889, to wind up and appointing Sir Julian Goldsmid, Mr. Brand, and Mr. Clare liquidators, and these resolutions were registered at Somerset House. The Post Office made a requisition that the winding up and the appointment of liquidators should be in conformity with the winding specialup Act, which requires a resolution to be passed by two meetings for winding up under the Act. The Company are advised that the resolutions passed in conformity with the deed of settlement are sufficient. The only mode of settling the question would be by a special case and argument before the Court, which would take much time and incur much expense. It was therefore thought advisable to have resolutions passed for the winding up in conformity with the Act, which is the reason for calling the present meeting, so that the resolutions having been passed in both forms all possible objections will be thus removed."

We shall be abundantly authorised, both as a chartered company and as a company registered under the Companies' Clauses Act, to wind up, and consequently the resolution I shall propose will be this:—

"That the Company be wound up voluntarily under the Companies' Acts' 1862 and 1867, and that Sir Julian Goldsmid, Bart., M.P. (the Chairman of the Company), the Hon. Henry Robert Brand (one of the Directors), and Mr. Stephen M'Donnell Clare (the Secretary), be and they are hereby appointed liquidators for the purposes of such winding up."

If Mr. Ponsonby will second that—

The Hon. ASHLEY PONSONBY: I will do so.

The CHAIRMAN; I think that will put you in possession of the facts of the case. I do not know that you will expect me to give you much additional information; but I think I may say that we are proceeding satisfactorily with the liquidation. As you have seen by the papers, we have arranged with the Government for the sale at a price—an inadequate price—of the cables; and we have arranged also for the sale of this house,

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the steamer, and, in fact, for the sale of all the property we had to dispose of. The Déolen cable, which belonged jointly to us and the Paris and New York Company, will in future belong absolutely to that Company, they paying us half-price, as was originally arranged in the agreement which we entered into with them. The only thing, practically, which we have to settle now is as to what is to be done with the Salcombe cable. That is a matter that will require still further negotiation and consideration, and I am not able to give you any information with respect to it. I have every hope in the course of a fortnight, or at the outside three weeks, that we shall return a very substantial part of the capital to the shareholders, and we hope that in the course of three months the liquidation will be completed. It is not possible for me to say at present what the exact amount will be, but we trust the shareholders will receive more than the capital of the Company ; and in the painful and trying circumstances in which we are liquidating I think that on the whole that is satisfactory. You may probably have seen the very hot discussion which took place in the House of Commons as to the price the Government pay us and the amount they have awarded as compensation to our *employés* whom they do not take over. I do not think that it is very desirable that I should discuss the proceedings in the House of Commons—first, because I am a member of that House, and secondly, because the vote is to be submitted to the full House on the report, and anything we might say here might interfere with that discussion. I think it is undesirable to say very much about it. It is the desire of the liquidators to proceed as rapidly as possible with the liquidation, and to return as much as they can to the shareholders. He then put the resolution to the meeting in the usual manner, and having declared it carried unanimously, stated that it might be convenient if he informed them that the meeting to confirm the resolution would be held on Wednesday, June 19th. Continuing, he said : In my opinion it is not necessary for us to pass the resolutions now which were passed at the last meeting, though we stated in the notice calling you together that we should do so. I do not think it is necessary to pass them for the reason that practically we have done everything. We have completed everything that was proposed in those resolutions except in regard to the Salcombe cable. It seems to me that under the ordinary powers of liquidators it is a part of their duty to sell and dispose of what property of the Company may be left. I therefore do not think it is necessary to pass all the resolutions in the notice of the meeting, but it may be advisable to pass the following one :—

"*That the liquidators be empowered to negotiate and sell, at a price to be fixed by valuation, or otherwise, the Salcombe and Déolen cables belonging partly to this Company and partly to the Société Carmichael et Cie.*"

The Hon. ASHLEY PONSONBY seconded the motion, which was unanimously agreed to.

At the suggestion of Mr. RUSSELL GRIFFITHS,

The CHAIRMAN afterwards submitted the two resolutions passed at the last meeting, empowering the liquidators to negotiate and sell at a price to be fixed by valuation or otherwise with the respective Governments any property belonging to the Company and the Société Carmichael et Cie., and authorising the liquidators to supplement the money which the Government has agreed to pay to the *employés* in England of the companies not taken into the service of the Government by a further sum not exceeding £500. These resolutions were also agreed to.

The CHAIRMAN : We have now proposed all the resolutions except the one as to authorising the Government to work the cables from the 1st of April. As they have been worked by them from the 1st of April I think it is unnecessary now for us to authorise them to do so (laughter).

In the course of a discussion which took place,

Mr. R. GRIFFITHS, in view of the Postmaster-General's recent remark in the House of Commons that the Company had been dealt with fairly and equitably, thought the shareholders should, as a body, express their opinion that the way in which the Company's property had been acquired by the Government amounted to a confiscatory act. The English Government, he added, had proposed confiscation to the French Government, who had been perfectly willing to assist the Company, but who, to protect their own nation, had been obliged to follow the lead of the English Government.

Mr. KING protested against the way in which the Company had been left to supplement the amount which the Government had agreed to award to *employés* not taken into their service. As to the terms on which the Company's property had been taken over by the Government, the Postmaster-General had admitted that, even in these days when there was competition, it would cost them £120,000 to lay new cables. It was, therefore, an act of injustice to the Company, the pioneer of submarine telegraphy, to require them to take a paltry sum of £40,000 or £50,000 for cables which, though not new, did their work perfectly well, and which would continue to work admirably. If the Government had given them £120,000 for the cables he would contend that they ought to have given more, as the cables had cost the Company more ; but the shareholders would have had less cause to complain had the amount in question been given them.

Mr. PAWLE said that the capital expenditure of the Company had been £331,000, and they would get back in round figures about £100,000.

The CHAIRMAN : I mentioned to the shareholders just now that we should repay them the whole of the capital, with probably some addition.

Mr. PAWLE : That is all very well, but we have a reserve fund.

The CHAIRMAN : That is included.

Mr. PAWLE inquired what had become of the capital ; how had it been expended ? Although they had spent the amount he had stated, and the auditors had said that everything was in perfect order, they were now to receive about £100,000, and he would like to know how the other £200,000 was to be accounted for.

The CHAIRMAN : With some of the remarks that have been made I can agree. I should agree that we are getting a very poor price for the property ; but I should not agree that the Government ought to pay us the price of new cables for old ones. It must be remembered also that when we laid our cables, cables cost a vast deal more than they do now, and it should further be remembered that one of our cables became an utter loss. Some of the remarks made would appear to hold me responsible because we did not get the value of the capital expended. The money has been honestly spent and certified by the accountants from time to time. It is unfortunate that our property does not represent the amount of value it originally held ; but it is fortunate that the Directors and the shareholders laid by a sufficient reserve fund, so that through that reserve fund and the amount we get for our cable, steamer, house, and other property, we shall get back our original capital with some small addition. Those who paid a high premium for their shares will not receive back that high premium ; but many who paid a high premium for their shares have been receiving high dividends, and if they were wise (as I am sure all our shareholders are) they probably put by a considerable proportion of their dividends as a sinking fund for their capital. Therefore, though I agree that we have not been handsomely treated, I can assure you that we have done our best to obtain the highest possible price for the Company. I have never gone through so much anxiety and given so much time to anything as to this matter, in the hope of obtaining reasonable terms for the shareholders. If I have not got all I hoped it was not because my colleagues and myself have not done our best. We must accept the position, which is disagreeable, but which might have been worse had not the shareholders and the Directors been a little provident.

The proceedings then terminated.

The Cuba Submarine Telegraph Company (Limited).

An extraordinary general meeting of the shareholders was held at the offices, 58, Old Broad-street, on Wednesday, A. F. Low, Esq., in the chair.

Mr. JAMES SCOTT, the secretary, read the notice, which stated that the meeting had been convened for the purpose of electing an auditor or auditors in the room of Mr. Thomas Greenwood, who has been appointed a Director to fill the vacancy caused by the death of Mr. Joaquin de Mancha.

The CHAIRMAN said : Before proceeding to the business of the meeting, gentlemen, I wish to give expression to the regret we feel at the loss of our late esteemed Chairman. We had the benefit of his experience during the fifteen years that he was a Director of the Company, and I am sure that during all that time nobody could have been more devoted to the discharge of his duties than he was. He was also a kind and genial friend and colleague, so that we have great reason to regret his loss. As the Board consisted of the minimum number of Directors required by the Articles of Association it devolved upon us to fill up the vacancy without loss of time, and we unanimously chose Mr. Greenwood, who has acquired a thorough knowledge of the business, and is otherwise highly qualified for the post. I have had the pleasure of Mr. Greenwood's personal acquaintance for many years, and I am sure that your interests will not lose anything by his appointment, which I hope you will cordially approve of. With these remarks, gentlemen, I now call upon you to elect an auditor in place of Mr. Greenwood.

Mr. SAVILE : Sir, I have great pleasure in proposing Messrs. Gane and Jackson, Chartered Accountants, of Coleman-street, as auditors of the Company. I have known them for many years, and I know that they are well acquainted with telegraph companies' accounts, and are quite capable and very desirable persons to act as auditors of this Company,

Mr. W. E. L. HOOPER seconded the proposition.

Mr. GRIFFITH : Are they shareholders in this Company ?

The CHAIRMAN : I believe they are not.

Mr. GRIFFITH thereupon offered himself to fill the vacancy, and in doing so referred to his long connection with the Company, and at some length detailed his qualifications for the post of auditor.

Mr. COCHRAN pointed out that nothing was said as to what the remuneration was to be.

The SECRETARY replied that whoever might be appointed would take the place of the auditor who was appointed for the current year, so that the usual fee of 20 guineas would stand.

After some discussion of a somewhat personal kind,

Mr. ROGERS proposed the election of Mr. W. Griffith as auditor.

Mr. FORSHAW seconded this proposition.

Upon being submitted to the meeting the vote was in favour of Messrs. Gane and Jackson.

Mr. GRIFFITH then said he was willing to serve as a second auditor in conjunction with Messrs. Gane and Jackson.

Mr. BOVILL proposed that Mr. Griffith should be so elected, and Mr. Rogers seconded the proposition.

The CHAIRMAN pointed out that for eighteen years they had never had more than one auditor, which was quite sufficient for the duty to be performed. The Company was only a small one, and it seemed unnecessary to add to the expenses by appointing a second auditor when a firm of accountants of high standing had been elected.

Mr. GRIFFITH said he would be content to divide the fee with Messrs. Gane and Jackson, so that the expenses would not be increased, or if the shareholders desired it he would do the work for nothing.

Mr. SAVILE, however, expressed his belief that Messrs. Gane and Jackson would not care to divide the small fee of 20 guineas with another auditor.

It was suggested that the Chairman should first take the sense of the meeting as to whether or not an additional auditor should be appointed. This was done, with the result that the majority decided against making any change.

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Mr. BOVILL moved that a vote of condolence should be passed to the widow and family of Mr. Joaquin de Mancha, the late Chairman of the Company.

Mr. COCHRAN seconded the motion, and it was carried unanimously.

A vote of thanks having been passed to the Chairman, the meeting closed.

Consolidated Telephone Construction and Maintenance Company (Limited).

The eighth annual general meeting of the shareholders in this Company was held to-day at the Cannon-street Hotel, under the presidency of Mr. C. L. W. Fitzgerald.

The SECRETARY (Mr. Charles Curtoys) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN: Ladies and gentlemen, it is with very great satisfaction that I address you to-day. It will be in your recollection that last year, in February, the Board terminated the contract for the manufacture of telephones which had been running with the American Telephone Company for some four years. We did not do so very badly under the contract, but I have, I think, to congratulate the shareholders on the fact that we have done a very great deal better this year. Later on I will tell you how much better, but I think I must say that the reason no doubt that we have done better is that we have looked into the question of manufacture more closely than when we were dealing with a contractor who simply sold us the instruments at a fixed price, and which we sold again. Leaving the figures to the last, I will deal with the report as it is laid before the shareholders. The profit you will see for the year, with the balance which we brought forward, amounts to no less than £13,286 for disposal, after making provision for doubtful debts. The Board propose to deal with this sum by paying a dividend at the rate of 7 per cent. for the half-year—making, with the interim dividend paid in November, 6 per cent. for the year—and writing off £520 for depreciation of plant, machinery, and furniture, and the sum of £2,000 off goodwill and patent rights, leaving a balance of £1,558 to carry forward. The action in Belgium is still dragging along, I am afraid I must say. When once one gets into law it is a very slow matter, but I can inform the shareholders that so far everything has gone in our favour. That, I think, is a great point, and we have now reached the stage when the question is to be put into the hands of experts to decide whether any infringement of our instrument has taken place or not. Of course, in my own mind I have not the shadow of a doubt that it has, but as we are dealing with a foreign Court it is not possible for us to say what the issue will be. We must, however, hope that it will be a favourable one. I now come to the question of the factory. I think I never was more pleased with the way things are going on at the factory than I am at the present moment. I find that everything goes on smoothly. I have not said previously very much about what we have been doing at the factory, but you must not imagine that we are standing still there. On the contrary we are making improvements—I may say immense improvements—in the instrument we are turning out; and we are also making great improvement in our machinery in the way of making parts of the instruments with labour-saving machinery—a proceeding which saves very considerably in the expenses of manufacturing. It is very gratifying to us to find that we are enabled to do that, and that our profit from the manufactory has been £4,000 more than it was in the previous year. In other words, last year we had a profit of £5,773, whereas this year we have a profit of £9,784. I think that it is very satisfactory to us to see that we have made nearly double the profit of the previous year, and I only hope that in the next year the profit will be trebled. There is really very little for me to say to you about the figures. I think this balance-sheet may be said to be a fairly intelligible one. You will see that we have received in interest from various subcompanies, dividends on shares, &c., £2,371, and that we have received £3,044 from the liquidators of the River Plate Telephone Company. We have done all that we can to keep down the expenditure, and I think I may say that we have very fairly succeeded. Considering that the profit shows so large an increase, I do not think the increase of expenditure has been so much. In the first item at least the increase is only £60. I think I need say very little except in so far as our plant and machinery are concerned. They are all in perfect working order, and we have reduced the value in the balance-sheet by a very considerable a mount. The stock of instruments has increased a little, but that is very natural with our doing a larger business. The item last year was £4,719, and it is now £6,453. The amount owing to us, it is rather gratifying to find by the balance-sheet, is £6,381, against £8,072 last year, while we owe, on the other hand, only £1,459, as against £2,025 last year. I think those figures ought to be considered satisfactory by everyone. As to the question of the relationship between the United Telephone Company and this Company, I am happy to state that it is very cordial indeed; in fact, there is no doubt about it that we have had a great deal more business from the United Company, and I am gratified to be able to state that it seems to me likely to increase. We now have a very considerable number of orders on hand to execute, and as far as I can judge, looking around England, I think the business is likely to increase very considerably. You see an item in the revenue account, "expenses in connection with the Lisbon Exhibition." That is a very small item—only £33. We exhibited some instruments there, and only this morning did we receive a telegram from Lisbon from the managing director of the Anglo-Portuguese Telephone Company, stating, "Have received flattering letter regarding instruments exhibited by Consolidated Company from the committee of the Lisbon National Exhibition. Being a foreign exhibit, medal could not be awarded." In other words, as we were foreigners they could not give us an award, but they gave us great praise for the instruments we sent to them. Now, gentlemen, I come to the subsidiary companies. I think it is most gratifying to find that year after year (this is now the fifth year) we are going on seeing an increase in the rental of those companies. This year there has been an increase of no less than 613 in the number of subscribers, while the increase in the rental has been £3,410. It is in connection with these subcompanies that the Directors have offered to the shareholders—or will offer to them—the 15,000 Preference shares out of the 75,000 which are to be created. I may tell you that in 1884 the income from those companies amounted to only £10,000, and that £10,000 was practically absorbed in working expenses. The gross annual income from those companies has now reached a sum of no less than £26,500, and their net income was for the past year £11,050. From that sum we have to deduct the debenture interest and the preference interest of those companies, but after that there is left a net balance of earnings by those companies of £7,200. At present the whole of these earnings are expended in construction. You will readily understand that to put up a telephone to earn an annual subscription costs a considerable sum of money, and as we find that no sooner is one man supplied than another wants to have similar advantages, the result is that all our net profit is absorbed in putting people on the telephone as fast as ever we can. It is for that reason that we have proposed to issue these Preference shares. The idea is this: We issue 15,000 Preference shares to the Consolidated shareholders, and we hand on the money to the subsidiary companies, taking from them securities which will pay us 6 per cent. or more, thus bringing us back the money which we should have to pay on our own Preferences. By doing that we shall give these companies capital to enable them to free the revenue which they get every year, and which keeps on increasing, and with that revenue free they will be enabled to pay us dividends. It appears to me that the proposal is of the very greatest advantage to the shareholders of these companies. I have always told you that I looked for very great results from the subsidiary companies paying us dividends. You see we receive already £2,700 from them. Of course it is only an estimate, but I estimate if we carry out this issue of Preference shares that we shall get, to begin with, £3,000 more, and that sum will go on steadily increasing as the companies grow. I hope, of course, that the shareholders will support us in this scheme. I shall feel very gratified if they do, and I can only say that we, the Directors, will do all we possibly can to keep up the state of efficiency which the Company has been brought to. If any gentleman has any questions to ask before I put the motion for the adoption of the report and accounts and the payment of the dividend, I shall be happy to answer them.

Mr. PERRIN said he saw that the United Company was to be absorbed by the National Company, and he asked whether the absorption by the latter company of the Consolidated Company's customers would lessen the sale of their telephones, and whether the Company supplied the National Company?

The CHAIRMAN: Does any other gentleman desire to ask any question? The agreement which we have with the United Company will be simply handed on to the National Company. We already supply the National Company. We supply the whole of the companies in England, and therefore it will not make the slightest difference to us. In fact, to tell you the truth, I think we shall probably benefit by it. I see that there is a great possibility of this amalgamation extending the business very largely, and that means more instruments to manufacture. I have now to propose—

"*That the statement of accounts and balance-sheet and the report of the Directors as now submitted to the meeting be received and adopted, and that a final dividend of 7 per cent. for the half-year, making, with the interim dividend previously paid, 6 per cent. for the year ended March 31, 1889, be paid.*"

Sir A. ARMSTRONG, K.C.B., seconded the motion, which was carried unanimously.

The CHAIRMAN next proposed the re-election of the retiring directors, Mr. J. H. Buckingham and Mr. Richard Van Zeller, who, he assured the shareholders, were excellent servants of the Company and valuable members of the Board.

Sir A. ARMSTRONG, in seconding the motion, endorsed the remarks of the Chairman.

The resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. H. GRÆWING, Mr. J. G. Griffiths was re-elected an auditor to the Company, the Chairman stating that he was very much satisfied with the way in which Mr. Griffiths kept the accountant up to his work.

Mr. RAINES afterwards moved, and Mr. GARDINER seconded, the re-election of Mr. A. E. Green, the other auditor, and the motion was also adopted.

The SECRETARY then read the notice convening the extraordinary meeting, the advertisement stating that the following resolutions would be submitted:—

"*That the capital be increased to* £307,545 *by the creation of* 75,000 *new shares of* £1 *each.*

"*That the new shares be called Preference Shares, and that the holders thereof be entitled to a preferential dividend at the rate of* £6 *per cent. per annum, payable out of the profits of each year, without any right in case of deficiency to resort to the profits of subsequent years.*

"*That the holders of the said Preference Shares shall be entitled on any distribution of the assets of the Company to be repaid in the first place the amount paid up on the Preference Shares held by them respectively, before any payment out of such assets to the other members of the Company.*"

The CHAIRMAN: I do not think, after the explanation that I gave, it will be necessary for me to go over the ground again, and therefore if it is your pleasure I will simply put this resolution to you as a whole. We

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might take them separately, but I think it would be quicker to take them as a whole. He accordingly proposed the resolutions as one.

Sir A. ARMSTRONG seconded the motion.

Major-General WESTROPP said that it was now proposed to increase the capital of the Company, whereas two or three years ago the capital was reduced by a return of 1s. a share to the shareholders, and some time before that the capital was reduced from 20s. a share to 15s. a share, the shareholders being mulcted of the 5s. If they were now to increase the capital of the Company he would like to know why they had received that shilling back. Would it not have been more useful to have kept it for the purpose for which money was now required.

Mr. LEATHERBARROW asked whether the Directors were satisfied with the securities they would receive from the subsidiary companies for the proposed advance to them of the £15,000.

The CHAIRMAN: Has any other shareholder any question to ask? Receiving no response, he continued: The first question was as to a quotation on the Stock Exchange. Until we have absolutely issued 50,000 shares no quotation could be granted on the Stock Exchange. I now come to the question about the return to the shareholders of 1s. a share. Of course, if we had kept that shilling we should have had money to advance to our subsidiary companies, but I confess I cannot see that it makes very much difference. It occurs to me that having given you back that shilling we have paid the shareholders a great deal more dividend on the 14s. remaining. As to the 5s. that was deducted, that was a different matter altogether. That event occurred before this Board came into office, and that was money that was lost by our predecessors. In the one case the shares were reduced by 5s. because that money was lost, and in the other case we returned them 1s. a share. It appears to me that there is a great deal of difference in the two proceedings. If the old Board had returned you 5s. instead of losing you 5s. that would have been doing what we have done. The other question asked was whether the Board are satisfied that we are going to get securities from the sub-companies which will be dividend-paying securities. Of course we are, or we should not propose what we are going to do. It is true that we hold a large portion of the debentures of these companies, but they have Preference shares and Ordinary shares which will pay dividends, and that will pay us a return on the money we propose to advance.

Major-General WESTROPP thought that before the capital of the Company was further increased the Directors should try and return what the former Board had taken away, and so make the shares their original value.

The CHAIRMAN: I do not think that that is possible or practicable. We have no capital to return. If you would like to have no dividends and receive the money back in that way you could get it; but I see no other way.

Mr. A. H. PINTO stated that as the Directors proposed to issue Preference Shares the Ordinary Shares would be affected; and he therefore asked if the holders of the Ordinary shares would be afforded the opportunity of exchanging them for Preference shares.

The CHAIRMAN: We have very carefully considered this. It has not been done hastily, but we could not, of course, do what this gentleman suggests. There would be no object in it. In my mind, this proposal of ours is going to increase the value of the Ordinary shares—that is my object—and not to depreciate them. He then put the motion, which was carried unanimously, and he subsequently announced that the dividend warrants would be posted on or before Tuesday.

Mr. BUCK proposed a vote of thanks to the Chairman, observing that the shareholders ought to congratulate themselves on having such a gentleman to preside over the interests of the company. He (the speaker) was an original shareholder, and he felt very much gratified at finding that the present Board were discharging their duties so satisfactorily to everyone.

Mr. HEYER seconded the motion, which was carried unanimously.

The CHAIRMAN: Gentlemen, I am very much obliged to you. As long as I possibly can you may be quite sure that I will watch over your interests and do the best that any man can do for you. I cannot say more than that.

The meeting then separated.

Hastings Electric Light Company.

The annual meeting of this Company was held on the 22nd inst. at the Works, Hastings, Mr. H. M. Baker, J.P., presiding.

In presenting their statement of accounts for the year ended March 31, the directors stated that in accordance with the views expressed in their report for 1888 as to laying new mains and procuring additional plant, they had purchased and fixed a new steel boiler on the premises at a cost of £749. 13s. 9d., and new mains had been laid, in order to extend the supply, at a cost of £284. The demand for incandescent lighting increases, the Company now supplying 984 lights, as against 864 per last report. The Directors, however, feel that an enormous increase could be made at once if sufficient capital was available for laying down new mains, and they are not without hope that arrangements may be made by which public and private lighting by electricity may be vastly extended. The revenue accounts showed a profit of £432. 2s. 10d.; from this must be charged the interest paid to bankers, £204. 0s. 6d., and interest on debenture bonds, £50, thus leaving a net profit for the year of £178. 2s. 4d., which, added to £108. 19s. 4d. brought forward from the last account, makes the sum of £287. 1s. 8d. available for dividend, out of which the Directors proposed to pay 5 per cent. free of income tax, which will amount to £205. 10s., and to carry forward the balance to the next account.

The CHAIRMAN, before moving the adoption of the report, read a letter from Mr. R. Hammond, expressing gratification at the report and regret that he could not attend the meeting. He urged the Directors to make application to Parliament this year for a Provisional Order, the first step being to go to the Corporation. Proceeding, the Chairman remarked that the Directors had that day completed seven years' service without fee or reward, and their services had been of no light character, but at times exceedingly onerous and difficult. They had had struggles such as few companies had had to contend with, but they were perfectly satisfied with the state of the electric light in the town, their primary object having been to promote the public interest. Two years ago they proposed to raise £5,000, but the response was simply *nil*. By personal application to several of their friends £1,000 was then subscribed in debentures, and with that they were just able to lay down additional plant and keep their heads above water. They could now double the amount of business if they had sufficient capital to develop it. He called attention to Mr. Hammond's letter because the Directors had decided to make application for the Provisional Order. Allusion was made in the report to the fact that arrangements might be made by which public and private electric lighting might be vastly extended. He did not think it would be advisable in public meeting to state what arrangements they contemplated, but they thought seven years was a long enough period to have devoted their energies to the Company. Therefore something would have to be done, and that soon. Owing also to the lack of interest taken in most public matters in Hastings the capital of the Company from the first was very meagrely subscribed, and Messrs. Beeching, the bankers, assisted them in developing the Company by a mortgage which they now wished to have paid off, and that was another reason why some arrangement must soon be made. Referring to the approaching advance of electric light in London and in Folkestone, he said that whatever might take place with reference to the Hastings Company they might claim that up to the present time there was no town in England where the electric light had been better supplied and with greater success, except from the shareholders' point of view, than had been the case at Hastings. The balance-sheet showed an expenditure of some £14,777. Whether that money has been well spent or whether

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The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
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PHOSPHOR BRONZE.
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BEARINGS, BUSHES,
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ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
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WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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they had got full value he was not going to say; but against it there was capital subscribed, £6,855; debenture, £1,000; and mortgage, £4,000; making together, £11,855, which left a balance of £2,922. Therefore, as a going concern, they had not got a very bad article to dispose of if they wanted to sell it. In all probability before another annual meeting came round the shareholders would be called together for some special purpose with reference to what he had already reverted to. In conclusion, the Chairman mentioned that the dividend would be paid as soon as possible.

Mr. REEVES seconded, and the report and balance-sheet were adopted.

Mr. J. WOODHAMS, in eulogistic terms, moved the reappointment of the Chairman and Councillor Roddis as Directors.

Mr. F. A. LANGHAM, in seconding, agreed with the Chairman that something must be done to start the Company with renewed life or wind it up, or at all events the present Directors should be relieved from the duties of office. He hoped that Hastings having been one of the pioneers in electric lighting would not drop it for others to take up. He was sure the townspeople would not like to see it dropped.

The CHAIRMAN, in replying, referred in high terms to the services of the Secretary and Mr. Mercer, the manager, and to the magnificent lighting of the Health Exhibition and its grounds by the Company.

United Telephone Company (Limited).

Report of the Directors for the year ending 30th April, 1889, to be presented to the shareholders at the ninth annual ordinary general meeting of the Company, to be held at the Cannon-street Hotel, London, E.C., on Tuesday, the 4th June next, at half-past two o'clock:—

Capital Expenditure.—A reference to the capital account will show that up to the 30th April, 1889, the sum of £299,211. 8s. 9d. has been expended upon the works in connection with the Metropolitan District and Instruments on Royalty in the Metropolitan District and Subsidiary Companies, being £35,334. 17s. 11d. more than the outlay shewn in the last balance sheet.

Revenue.—The revenue accounts, exclusive of Metropolitan District Royalties, show that the receipts of the Company from all sources properly attributable to the year have been £152,804. 10s. 9d., as against £143,134. 18s. 5d. in the preceding year, or an increase of £9,669. 12s. 4d.; and the expenditure has been £58,540. 12s. 2d., as against £73,519. 8s. 8d., or a decrease of £14,978. 16s. 6d.

Working Expenses.—Metropolitan District.—The working expenses for the year have been £36,895. 9s. 5d., as against £35,724. 12s. for the preceding year, or an increase of £1,170. 17s. 5d.

Dividend.—The balance of net revenue account is £87,642. 0s. 5d., of which amount the sum of £25,000 has been absorbed by the payment of an interim dividend at the rate of 10 per cent. per annum for the first half-year ending 31st October, 1888, and the Directors recommend a further dividend of 12s. 6d. per fully paid £5 share for the second half-year ending 30th April, 1889, amounting to £62,500, making a total dividend of 17½ per cent. for the year, leaving a balance of £142. 0s. 5d., which has been carried to the reserve account.

Reserve Account.—The reserve account has been increased during the year by the sum of £9,680. 3s. 3d.

The Compagnie Continentale Edison.

In the report recently issued by the Directors of this Company it is stated that the past year was signalised by an incontestable progress in the electrical industry generally. The Paris Municipal Council had authorised the lighting of the capital by electricity. This decision gave a special importance to the Company's undertaking, and last year they acquired the electric station of the Cité Bergère, and obtained from the municipality the concession for a part of the canalisation of the City of Paris, which has for its base the line of the Grand Boulevards, from the Faubourg St. Denis to the Grand Hôtel. The works were begun, and the central station of the Cité Bergère will furnish the electric current for the lighting, under the contract secured by the Company for a portion of the Boulevards. This station, which formerly supplied 1,000 lamps, now supplied about 4,000. They had finished the station in the Cour d'Honneur of the Palais Royal, which enabled them to connect the working of the Comédie Française and the Palais Royal Théâtre to the lighting of the various shops and galleries. This station began work at the commencement of the year. These two stations have necessitated the employment of a large capital, which during the last financial period has been unproductive. This accounted for the small dividend which was proposed, but there was reason to regard the future of the company with confidence. The lighting which they had undertaken had given the best results. They had obtained a grand medal of honour at the Barcelona Exhibition. Electric lighting and the transport of power will extend greatly in France, thanks to the Exhibition. They had ceded their patents for the manufacture of lamps to the Compagnie Générale de Lampes Incandescent. That company gave them in the first half-year of its existence 6 per cent. per annum, at the same time putting by a large reserve. Taken altogether, the working for the year 1888 shows a profit of 262,066 francs, which they propose to divide as follows:—5 per cent. to the reserve, making 13,103 francs; 4 per cent. interest on the shares, *pro rata temporis*, or at the rate of 20 francs for the 7,000 old shares, making 140,000 francs; and at the rate of 12 francs 91 centimes for the 7,000 new shares, making 90,416 francs. These sums together make a total of 243,519 francs, and leave a balance of 18,546 francs to be placed to the profit and loss account for 1889. Again, after a distribution of 42,000 francs, at the rate of 3 francs per share, on the 14,000 founders' shares of the company, there remained a balance of 8,545 francs, which it was also proposed to distribute.

NEW COMPANIES REGISTERED.

HALIFAX AND BERMUDAS CABLE COMPANY.—The Capital and Counties Bank has been authorised to receive subscriptions for £120,000 Four and a-Half per Cent. Debentures of this company at the issue price of £102 for each £100 bond. According to the prospectus the proceeds of the loan are to be devoted chiefly towards the construction and laying of a telegraphic cable between Halifax, Nova Scotia, and the Bahamas. The sum of £15,000 is to be deposited with the Government as security for the due performance of the contract. The Government has agreed to pay the company an annual subsidy of £8,100 for twenty years, and this sum will be devoted to the service of the debenture debt. The subject is further dealt with in our Leading Article.

THE PORTSMOUTH AND SOUTH HANTS ELECTRICITY SUPPLY COMPANY.—On the 23rd inst. a company was registered under the name of the Portsmouth and South Hants Electricity Supply Company (Limited), with the nominal capital of £50,000, for the purpose of supplying Portsmouth and the vicinity with the electric light.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended May 24, 1889, amounted to £5,313.

HAMBURG-HELIGOLAND CABLE.—Since the 1st April this cable has become the property of the German Government, and the old company is now in liquidation.

SPANISH NATIONAL SUBMARINE TELEGRAPH COMPANY.—The numbers are announced of 72 bonds, amounting to £7,200, of this company's Six per Cent. Mortgage Debentures, to be paid off at par at the offices of the company, 106, Cannon-street, E.C., on and after June 29 next.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended May 24, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,813.

BUSINESS NOTICES.—Messrs. W. H. Willcox and Co., of 36, Southwark-street, London, S.E., announce that they have taken over the premises, business, goodwill, and stock of Messrs. W. Goodwin and Co., leather machine band and hose pipe manufacturers, &c., and are now giving special attention to this department.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

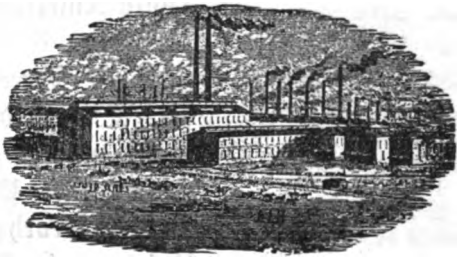
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, May 29, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending May 29, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	52 53	3 15 6	Jan., Apr., July, Oct.	52	51⅞
2,614,320	Stock	25/0	Do. Preferred	89 89	4 9 11	,, ,,	89	87½
2,614,320	Stock	...	Do. Deferred	18½ 19	...	February	19	18⅝
130,000	£10	3/0	Brazilian Submarine	13⅝ 14	5 0 0	Mar., June, Oct., Dec.	14	13⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	102	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19 20	5 0 0	,, ,,	19⅜	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅞ 4½	4 4 8	March & September	3⅞	...
6,000	5	5/0	Do. Preference 10%	8⅞ 9⅜	5 5 3	April and October	...	...
60,710	20	3/6	Direct United States	10⅝ 10¾	5 1 2	Jan., Apr., July, Oct.	10⅞	...
380,000	10	2/6	Eastern	13⅛ 13⅜	4 9 9	,, ,,	13⅜	13⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15½	3 18 8	,, ,,	15⅛	14⅜
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	5/8	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13 7/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	104½	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	105½	...
179,177	10	3/0	Globe Telegraph and Trust	7⅞ 8½	5 10 9	Jan., Apr., July, Oct.	8 1/16	7⅞
178,992	10	3/0	Do. 6 per Cent Preference	14⅝ 14⅞	4 0 8	,, ,,	14 11/16	14 9/16
150,000	10	5/0	Great Northern	15⅛ 16	4 13 9	Jan., July, and April	16	15⅞
17,000	25	2/6	Indo-European	39 41	6 1 11	April and October	41	40⅛
9,000	8	8/0	Reuter's	7 7½	5 6 8	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	9⅛	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	103	102
80,000	10	6/0	West Coast of America	10 10½	4 15 3	January and July	10½	10 1/16
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2⅝	2 1/16
34,563	10	12/0*	Do. 1st Preference 6%	11¾ 12¼	...	April and October	11¾	...
4,669	10	†	Do. 6 per Cent. 2nd Preference	13⅛ 14½	...	...	...	...
45,181	15	6/0	Western Brazilian	13 13⅜	...	March & September	13¼	13
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	4½d.	Consolidated Telephone and Maintenance	1⅛ 1⅜	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	1/16 7/16	...	...	...	...
80,000	5	5/0	United	15¾ 16¼	4 12 4	June and December	16	15⅞
55,000	5	3/0	United River Plate	6¼ 6⅜	...	January and July	6⅜	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3¼ 3⅜	...	...	3¼	...
23,692	5	2/0	Do. (fully paid)	4 4½	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	2⅜ 3¼	...	...	2 1/16	2⅞
			MISCELLANEOUS.					
87,350	12	36/0	Telegraph Construction and Maintenance	41 43	5 11 9	March and July	42½	42
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19½	...

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIDUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
M. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
J. G. Statter & Co., Limited.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 577.—Vol. XXIII. FRIDAY, JUNE 7, 1889. Price Fourpence.

NOTES.

The Board of Trade has refused the application made by the Brighton and Hove Electric Lighting Company for a Provisional Order for that district. It will be remembered that an Inquiry was held in Brighton on April 11th (see *The Electrician*, April 19th), when it appeared that the application was strenuously opposed both by the Brighton Corporation and the Hove Commissioners. The application for a Provisional Order made by the Corporation of Swansea has been granted.

We are happy to find that the London County Council has raised no objection to any portion of Major Marindin's proposals. The Council is, however, of opinion that "as the representative governing body of the whole of London it should be appointed the controlling authority." From the text of their letter (which will be found in another column) it is plain that the Council has no very clear idea as to the existing division of responsibility betwixt the local authorities and the Board of Trade, but if its ambition will be satisfied by a transfer of the functions at present exercised by the local authorities we see no reason to object. The Supply Companies in the Metropolitan district would be better off in having to deal with a single authority in place of the existing twenty-nine. On the other hand, it would certainly be wiser to allow the question to rest for a year or two whilst the Council is getting fairly into harness. As to transferring to such a body any portion of the specific duties of the Board of Trade, we think that nothing could be more objectionable;—happily this is not a question of practical politics. The Council proceeds in a light-hearted sort of way to talk of the probability of its undertaking the wholesale construction of subways into which all wires should be "compelled" to go. From the point of view of the electrical interests nothing could please us better. By all means construct adequate subways throughout the town; we can promise that there will be no difficulty in getting the companies to use them. But what will the ratepayers have to say? Has the Council formed any idea of the probable cost?

At the meeting of the Committee of the Electrical Trades Section of the London Chamber of Commerce, held on Monday afternoon, it was decided to hold an Extraordinary General Meeting of the Section on the 24th inst., when a report will be presented. It is also proposed to follow the precedent of the Council of the Chamber of Commerce by inviting the members to attend all the meetings of the General Committee, any member being entitled to speak upon any subject on previously giving notice of his intention to the Chairman. Arrangements will probably be made to publish the agenda in the technical journals the week previous. A copy of the proposed Regulations relating to Overhead Wires was received from the Board of Trade, and referred to the Committee already sitting. It was decided to ascertain whether, as a step towards uniformity of gauge, the trade in general is disposed to adopt the "British Association" Screw Threads. The project for establishing a Standardising Laboratory has advanced a further stage, and a meeting of the joint Committee (of the Section and the Institute) was held on Wednesday last, when a detailed scheme which had been drawn up by a sub-committee was provisionally adopted.

Major Flood Page has addressed a letter to the daily papers on the subject of Major Marindin's report, with which the majority of our readers can scarcely fail to find themselves in agreement. The writer bears testimony to the general fairness and independence of judgment which characterises the report, but his chief object is to draw attention to the importance of the step about to be taken by the Board of Trade in the issue of a Model Provisional Order. This, indeed, in our own view, is a task requiring a degree of knowledge, skill, and judgment fully as great as that demanded for the work hitherto accomplished, whilst it has a far wider import for the industry at large. And although we have reason to place confidence in the wisdom of the Board of Trade and its advisers, yet we would emphatically endorse the view of Major Flood Page when he says: "Whatever care may be bestowed on the drafting of the Model Provisional Order, provision should be made for its easy and inexpensive amendment as the necessity for change becomes manifest." The writer goes on to express the belief—about which there can scarcely be two opinions—that "no body of men are yet sufficiently acquainted with the development that electric lighting will take to draft an unalterable Model Order." In concluding his letter the Major instances the fact that already since the issue of the report the question of alternating motors has undergone fresh development at the hands of Mr. Mordey, and probably also by Ganz, of Buda-Pesth.

With regard to the issue of a Model Order, it appears to us that the chief difficulty will be to find any stereotyped formulæ whatever to cover all the multitudinous possibilities incidental

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to variations of Time and Space, to say nothing of System. It would at least seem necessary to provide alternative readings for many of the clauses.

THE issue this week of the prospectus of the Electric Construction Corporation (Limited) may probably be taken to mark the advent of a new era in the history of electrical engineering in this country. We saw last year that the City would find money for well-considered and properly backed-up schemes for Electricity Supply Companies, but in the successful floating of an undertaking for the manufacture of electrical apparatus and the erection of electrical plant a very distinct step in advance has been made. The Company in question has been formed for the amalgamation and purchase of the follow-lowing undertakings:—Elwell-Parker (Limited), of Wolverhampton; the Electrical Power Storage Company (Limited), the Railway Electrical Contractors (Limited), the Julien Patents for the United Kingdom for Electric Traction, and the Sprague Patents for the United Kingdom. The two first-named are perfectly well known throughout the entire electrical world as amongst the earliest formed and most extensive concerns in this country. The Railway Electrical Contractors (Limited) is a smaller affair, but one whose future was in any case well assured. Our readers are aware of the successful work carried on for many years on the Brighton line, and of the recent partial introduction of the system on the Midland Railway. With the two latter Companies, both of foreign origin, we cannot profess to be so well acquainted. The combination will, no doubt, be strengthened by their accession; and as for the Sprague business it is well known as being one of the most successful electric traction undertakings in the United States. It will thus be seen that the Corporation is, or should be, well equipped for almost every kind of undertaking connected with electrical engineering, and under reasonably good management it can scarcely fail to attain a markedly successful future. Something, of course, depends upon the *personnel* of the technical staff, and we trust that a judicious selection will be made.

IT was a most unfortunate "concatenation of circumstance" which reduced the period available for the discussion of Mr. MORDEY'S Paper to a single hour. Had the Fates been reasonably propitious a Paper of such quality (and dimensions) might well have occupied the attention of the Institute for three whole evenings at the least. However, it is useless to indulge in vain regrets, and we have at any rate the gratification of recognising that such discussion as the Paper did receive was quite of the highest order almost throughout. Prof. FORBES, on behalf of Dr. HOPKINSON, did well to call renewed attention to his (Dr. HOPKINSON'S) Paper of 1884 (see *The Electrician*, Nov. 15, 1884), in which the theory of alternators received well-nigh complete development. Dr. HOPKINSON'S equations show that the most favourable condition for parallel working is attained when the period is equal to 2π times the time-constant of the circuit, so that it is not necessary to aim at the reduction of the self-induction without limit. We need hardly emphasise the value of the knowledge of this relation, but it seems almost a pity that Dr. HOPKINSON allowed the profession to remain so long oblivious to the discovery which he had placed on record.

MR. KAPP seeks to reconcile the theory with which his name and that of Prof. FORBES is identified with the experiments of Mr. MORDEY by assuming that when the coils of the armature are directly opposite the pole face "its self-induction is nearly as great as if the iron passed right through," and that in this position the self-induction is "far greater" than it is when the coils are in the intermediate position. This conclusion is not borne out by the secohmmeter measurements made by Prof. AYRTON'S students, in which the difference was shown to be little more than 5 per cent., and the variation is actually in the opposite direction. We do not, however, feel sure that this discrepancy is in itself sufficient to entirely vitiate Mr. KAPP'S argument, which, though it undoubtedly requires modification, seems to us to have some solid foundation. The reaction is evidently extremely complex, and probably a mathematical investigation would show that certain factors assume greater relative importance than at first sight appears. It is a pity that we have no measurement of the self-induction of the armature itself when clear of the field magnets. It will be remembered that in one of the experiments a machine, excited to 2,000 volts, was made to drive as a motor a similar machine excited to only 1,000 volts, and that each voltmeter then read 1,500. Mr. KAPP seeks to explain this by the demagnetising action of the armature upon the field of the generator and the reverse effect upon the field of the motor. It seems difficult to believe that this is the true explanation—if it were, the self-induction of the armatures would necessarily be enormous, and we should expect to find an altogether disproportionate waste of energy in the heating of the unlaminated pole pieces. Besides, as Prof. S. P. THOMPSON pointed out, 1-200th of a second is not long enough for such a reaction to take place. It seems, moreover, unnecessary and erroneous to assume that the back E.M.F., *due to the field of the motor*, is itself raised from 1,000 to 1,500 volts. Under the conditions of the experiment the two voltmeters were virtually coupled terminal to terminal, and must necessarily give the same indication. The whole question will doubtless before long receive further elucidation.

OUR New York correspondent sends us this week a detailed account of what cannot fail to be considered one of the most extraordinary achievements of mechanical and electrical engineering on record. His letter contains also a description of the Thomson-Houston Electric Railway at Topeka—the largest undertaking of the kind yet in existence.

Sebastopol.—The municipality of Sebastopol have decided to light the town by electricity, and tenders will shortly be asked for.

Swansea.—Consent has been obtained from the Board of Trade to the application of the Corporation for power to light the borough by electricity.

Royal Society.—The following Paper was down for reading yesterday afternoon at the Royal Society: "Electro-Chemical Effects on Magnetising Iron," by T. Andrews, F.R.S

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The Lighting of Dublin.—Hastings was last week visited by a deputation from Dublin, who went there for the purpose of making inquiries concerning the question of electric lighting.

Honours.—*Indian Engineering* says that Mr. Barker, who had charge of the telegraphs in the Black Mountain Expedition, has been awarded the Companionship of the Indian Empire.

The Electric Light in Yucatan.—Mexican advices state that the city of Merida, the capital of Yucatan, was on April 3 lighted by electricity. The plant was erected by American electricians.

Paris.—The first of a set of three cars driven by electricity has been running for the last few days on the Madeleine-Porte-de-Courcelles Tramway. The car is of a heavy description, and carries 49 passengers.

Llandudno.—The Pavilion and Pier Company at Llandudno are laying down an engine and apparatus for lighting up the pavilion and pier, and the George Hotel is already fitted throughout with the electric light.

Sheffield.—The *Sheffield Daily Independent* notes that 55,538 messages were sent through the office of the Sheffield Telephone Exchange and Electric Light Company during the week ending May 24th, as against 23,904 messages in the corresponding week of last year.

Smart Work.—We learn that the result of the Derby, which reached the Direct United States Cable Company's Throgmorton-street office at 3h. 8min. 30sec. p.m. from Epsom, was transmitted to New York and delivered to the addressee at 3h. 8min. 32sec. p.m (Greenwich time). This beats all record.

Institute of Electrical Engineers.—On Friday evening last, by kind permission of Mr. Spagnoletti, the students visited the electric light station of the Great Western Railway at Paddington. They were conducted round the station by Mr. Walton, who explained the whole of the working to them, the visit being both pleasant and profitable.

Telegraphic Communication with South Africa. — The Eastern Telegraph Company announces the opening for traffic of the Eastern and South African Company's new West Coast cable to Cape Town. This will afford an alternative means of telegraphic communication with South Africa. Telegrams can be sent by either the East or West Coast cable routes at the same tariff.

The late M. Gaston Planté.—M. Gaston Planté has bequeathed to the Academy of Sciences a sum that will admit of the award of a prize of 3,000fr. every second year to some Frenchman who has distinguished himself by a study of the science of electricity. In addition, M. Planté has left his house and large gardens at Bellevue, near Paris, as a place of retreat for poor scientists.

Personal.—Mr. J. Carruthers Allan, lately representing the African Direct Telegraph Company at Lagos (West Africa), and also holding the post of His Danish Majesty's Consul at that port, had the honour of being presented at Court and of an audience with H.R.H. the Crown Prince of Denmark during a recent visit to Copenhagen. Mr. Allan is now proceeding to take temporary charge of the above company's station at Bonny.

Institution of Civil Engineers.—The Council has awarded the following premiums in respect of the original communications on electrical subjects submitted during the session 1888-89 :—A Telford medal and a Telford premium to Gisbert Kapp, Assoc.M.Inst.C.E., for his Paper on "Alternate-Current Machinery." A Miller prize to Samuel Joyce, jun., Stud.Inst.C.E., for his Paper on "Electrical Measuring Instruments: their Properties and Calibration."

Florence.—A Belgian company, the Société Anonyme Belge pour l'Éclairage et Transmissions Électriques à Longue Distance, has obtained a 40-year electric lighting concession for the towns of Florence and Pistoria. The system employed will be that of M. Léon Gérard, who uses accumulator sub-stations. The company has already applications for over 6,000 lamps for a minimum period of three years. M. Gérard's method has been for some time in successful operation in Brussels, at the Théâtre de la Monnaie.

The Telephone in Java.—In Java, under the rule of the Dutch Government, great progress is being made as regards the use of the telephone. During the past year five concessions were granted for erecting telephonic lines at various places throughout the island. In the interior of the island seventeen places where the telegraph does not exist have been connected by the Government to the nearest telegraph stations by telephone. In Batavia, Samarang and Sourabaya the telephone has met with great success, and is highly appreciated.

Telephone Patents in France.—In 1882 the Société Générale des Téléphones seized a number of telephone instruments in Paris and the provinces, which they held to be infringements of the patent rights held by the Société. The confiscation of these telephones was demanded, together with damages, and the insertion by the defendants of the judgment in twenty French and foreign papers. "We learn, however," says, *Industria*, "that M. le Procureur de la République has finally refused the demands of the Société Générale des Téléphones."

Holborn Board of Works.—At the meeting of this Board on Monday last a letter was received from the Board of Trade stating that electric lighting companies would be compelled to lay mains in the list of scheduled streets within a specified time. In the determination of this list the Board would be largely influenced by the views of the local authorities, therefore they would be glad to receive from them at the earliest possible period a list of the streets in their district which in their opinion should be so scheduled. The communication was referred to the Works Committee.

Montevideo.—In 1887 the Montevideo Electric Lighting Company obtained a concession for the public lighting by electricity on condition that it carried out the street lighting within eleven months. Although the period has been twice extended—first for nine months and then for five and a-half months—nothing has up to the present been done. The gas company has now entered a formal protest against this concession and the extensions of time as a violation of their contract with the authorities, which gives them the preference on equal terms over any other company offering to undertake the public lighting.

Haarlem.—The Haarlem Scientific Society asks for Papers on the two following electrical subjects, the competition to remain open until January 1, 1890 :—1. An experimental or theoretical investigation extending our knowledge of inductive and electro-dynamic phenomena. 2. An experimental or theoretical determination for one or several substances of the influence exercised upon specific inductive capacity by compression in the direction of or perpendicular to the E.M.F. These Papers may be written in English, French, German, Italian, Dutch, or Latin, and must be sent, accompanied by a sealed envelope containing the name of the writer, to the Secretary of the Society, Prof. J. Bosscha.

Copper.—The new copper combination, as to which so many conflicting reports have been current, says the *Financial News*, is, it seems, going to pull through after all. Yesterday the last of the American companies which had been standing out came to terms, namely, the Yamarack. The English companies have only been waiting for the Americans, and a similar agreement among them is practically assured. The effect of this arrangement will be to relieve the copper market for a considerable period from any risk of having the defunct Syndicate's stock thrown on to it. Manufacturers, being freed from that danger, will now buy more freely, and a gradual advance in price to about £45 per ton is aimed at.

Theatre Lighting.—At Magdeburg the town theatre has replaced gas by the electric light. According to the *Gas World* the average quantity of gas previously consumed was 2,224,971 cubic feet in the season. The engines put in were two Otto (Deutz) 40-horse, one five-horse Otto, and a two-horse gas motor; and three continuous-current dynamos, Edison pattern, 240, 240 and 30 amperes, all at 105 volts tension. The lamps are glow-lamps, 75 of ten, 433 of sixteen, 356 of twenty-five, and 160 of thirty-two candle power. The orchestra is lit up by gas; the passages have electric light, gas and oil lamps. During last season there were used 1,805,546 cubic feet of gas. Heating and lighting the machine-room took 77,556 cubic feet.

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Cooling the machines took 212,007 cubic feet of water. The number of evenings during the season was 182, and during the season there was no hitch in the electric lighting.

The "Lancaster" Catalogue.—The 1889 edition of this well-known catalogue, issued by Messrs. Lancaster and Tonge, of Manchester, contains several important additions to that of last year. Amongst the new items we notice the "Lancaster" self-adjusting bearing, which is arranged so as to swivel in either a horizontal or vertical direction, a great advantage in the case of a crooked coupling or an untrue shaft. A magnetic indicator and high and low water alarm, devised by MM. Lethullier and Pirrel, is also described and illustrated. Besides showing the height of the water in the boiler this apparatus actuates two whistles giving different sounds whenever the water is either too high or too low. These are some of the many additions to this useful catalogue. The general appearance of this publication would, we venture to think, be considerably improved by a somewhat less liberal underlining of the testimonial pages.

Annual Conference of the Postal Telegraph Clerks' Association.—The annual conference of the Postal Telegraph Clerks' Association of the United Kingdom was held at Bristol on Saturday last, under the presidency of Mr. E. C. Taylor. The most important matter discussed was the motion of a Bristol delegate respecting payment for Sunday labour, the department at present maintaining that payment is made for two hours each Sunday, and requiring the clerks to work a full day once a month. This, it was pointed out, had always been a sore point with the clerks. Although Sir John Puleston had rendered good service to their cause, yet at a critical moment he failed to move the resolution which was expected from him in the House of Commons. Mr. Bradlaugh, however, had come to the rescue, and had a motion on the books of the House to the effect that all labour performed on Sundays should be paid for as extra duty. He was now awaiting his fortune in the ballot to bring it forward. A resolution was carried directing inquiries to be made into the pension question.

Wolverhampton.—The *Birmingham Gazette* says:—"We some time ago drew attention to the intended removal of the electrical engineering works of Messrs. Elwell-Parker (Limited), Commercial-road, Wolverhampton, to new and commodious premises about to be erected on a plot of land situated between the Stafford-road and the London and North-Western Railway at Bushbury. Owing to the extensive character of the new structure additional land was found to be necessary and 11¼ acres more ground have been purchased, and the total area of the land of the company now will be 24¼ acres. In addition to carrying on the manufacture of electrical apparatus, for which Messrs. Elwell-Parker are well known, it is intended to branch out into the making of chemical products by electro-chemistry, for which the company hold a number of patents. Amongst other matters it is proposed to turn galvanizers' waste acid or "pickle" into a merchantable commodity, a process having been discovered by the chemist to the firm which it is believed will prove eminently successful."

The Electroplating of Glass and Porcelain.—According to the *Moniteur de la Céramique et de la Verrerie*, a method of electroplating glass and porcelain has been devised by M. Hansen. The chief difficulty hitherto experienced has been to obtain a conducting surface which would not prevent the proper adherence of the metallic coating. M. Hansen uses chloride of gold or of platinum dissolved in sulphuric ether, to which sulphur dissolved in some heavy oil is added. This compound, after having been slightly heated, possesses sufficient consistency to allow of a film being laid on the glass with a brush. The object treated in this way is then moderately heated in a muffle until the sulphur and chlorine are completely volatilised, the gold or platinum adhering firmly to the surface. The best copper bath is two parts of sulphate of copper to three of distilled water. In silver plating, 17 parts of nitrate of silver and 13 parts of cyanide of potassium dissolved in 300 parts of water are used. For gold plating, seven parts of gold are used, which are preferably dissolved in aqua regia, and precipitated by means of ammonia. This precipitate, while still wet, is then placed in a warm solution consisting of 9 parts of cyanide of potassium and 90 parts of water.

Improvements in the Wimshurst Machine.—With a view of adapting it to medical purposes, M. Oudin has introduced several modifications in the Wimshurst machine. The two large glass plates are replaced by ebonite discs 50 centimetres in diameter. These discs are provided with wooden projections covered with tinfoil, so that the brushes do not touch the plates themselves. Brushes, combs and plates are mounted so that they can be easily altered as required. It is possible, for instance, to do away with two plates and transform the whole arrangement into an ordinary two-plate machine. The condenser employed by M. Oudin is of a somewhat peculiar character. It consists of glass plates 24 by 18 centimetres, on to one side of which is fastened a narrow strip of varnished tin 3 centimetres broad; these strips start from the smaller sides of the plates, and are about 17 centimetres long. The plates are arranged one on the top of the other to any required number, the ends from which the metal strips start being laid alternately left and right, and the strips themselves being connected to two metal pillars in connection with the machine. The combs employed by M. Oudin have toothed edges in lieu of the usual long projecting points.

Resistance Coils for Use with Alternate Currents.—In a Paper read before the Société Française de Physique M. Chaperon recently described a method of winding resistance coils so as to enable the Wheatstone Bridge to be employed in alternate-current work. With a telephone instead of a galvanometer, a balance, when the present form of coil is used with alternating currents, is denoted merely by a minimum of sound, not by complete silence, so that any approach to accuracy is impossible. M. Chaperon, in common with Kohlrausch, Cornu, and others, was inclined to attribute these disturbances to electrostatic rather than to inductive effects. He therefore first of all experimented with two coils identical in every respect except that one was wound as a solenoid and the other like the coil of a resistance box. Much better results were obtained with the former than with the latter, although, of course, the self-induction was much greater in the first case. M. Chaperon, therefore, while taking care to have inverse currents in the adjacent portions of his coils, endeavours to diminish electrostatic effects by arranging matters so that the difference of potential between these adjacent portions shall be a minimum. This is effected by winding the coil in several sections and taking the greatest care to keep the thickness of the insulation rigorously equal in every part. M. Cornu, who assisted M. Chaperon in these investigations, says the new form of coil gives excellent results.

The Argentine Telegraphs.—At the recent opening of the Congress the President gave the following information about the telegraphs of the Republic:—Our telegraphic management is steadily improving. Telegrams show an increase of 6 per cent. over the figures of 1887. In 1887 official messages amounted to 25,554, whilst in 1888 the number fell to 12,443, a decrease of 50 per cent.; this is due to the stoppage of the great abuse in the use of free messages. A reduction in tariffs is generally followed by a falling off in revenue the first few years, yet we see that, although the tariff was reduced 37 per cent., the revenue increased 62 per cent. New postal and telegraph offices have been opened to the number of 212; 5,359 kilometres of telegraph line have been erected, 5,062 kilometres have been repaired, 3,811 kilometres have been reconstructed, 3,529 kilometres of new line have been contracted for, making a total of 17,781 kilometres of telegraph lines. New lines built and repaired make up a total of 10,449 kilometres for the year's work, say, at the rate of 28 kilometres per day. When all the contracted lines are complete the Republic will have a complete telegraph system connecting all the principal points of the country. The first cable will shortly be laid between the capital and Rosario. With the view of extending the telegraphic service with Europe a contract has been signed *ad referendum* with Messrs. Bieckert and Co. to lay a cable from Buenos Ayres to Lisbon.

An Erratic Lightning Flash.—A peculiar case, illustrating the vagaries of lightning, is reported from Poundridge (Westchester County, U.S.A.). An old-fashioned square-built cottage, with a chimney in the centre of the roof, was struck during a thunderstorm, and two out of the eight people inside were

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killed. The chimney was shattered to pieces, and the bricks were hurled yards away. The account then goes on to say that the flash separated into four main currents. "One of them flashed down the space left by the wrecked chimney, tore open the ceilings, and leaped to a stove-pipe leading to the stove in the room where the people were sitting. The chairs were split in two, the window panes were dashed from the sashes, and the door was splintered. A second current went along the roof to a tree on the east side of the house, stripped the bark from the tree and leaped 20 feet away to a fallen tree, knocking it into splinters. The third current made its way to another tree on the north side of the house, cleft it in twain, and following the course of its roots, tore up the earth on all sides. The last current spread out in opposite directions in the ceiling of the lower floor. The plastering was scattered in the finest powder, while the laths looked as if a coarse-toothed saw had cut an opening in them from one end of the house to the other. Every dish was broken to pieces, the outer walls were forced out, while the inner and less substantial walls were twisted out of shape and torn apart. Beams and boards were split and splintered into kindling-wood."

Lightning.—The following abstract from a report by a German lightning rod inspector will be of interest at the present time. Herr F. Niesen, whose Paper appears in the *Elektrotechnische Zeitschrift*, No. 689, says that for the last seven years he has had charge of the rods on the Berlin Inland Revenue buildings. At the beginning of that time he found them in a very unsatisfactory condition, and had many of them repaired. Since then all the conductors have in general lasted well—both copper rope and also iron rod and rope, the principal cause of injury arising from the presence of workmen on the roofs. Speaking of the value of resistance tests to discover faults, he considers them of great value, as he has several times detected by that means cases where the wire was eaten through by corrosion, and yet did not show it visibly without the very closest inspection; he has also detected sundry bad joints by the same means. The earth test he uses is simply to measure the resistance between the conductor and the nearest water-pipe; with an ordinary bridge of course polarisation is an objection, but is not sufficient to prevent the test showing whether the resistance is over or under two ohms, which is all that is required. Where there are several earth plates there should be means of disconnecting each of them from the conductor for testing, otherwise they may all be bad but one, and yet test as below two ohms. Several interesting strokes are mentioned. In one case, in Holland, a water mill was struck (no rod); the lightning, coming down the front of the house, broke through to the top of a looking-glass inside, and then out again at the bottom, only injuring the silvering at the point it entered and left, and at the line between the top and bottom half of the glass, which was made in two pieces. Another, and at the present time more interesting case, is that of a house with a rod, which was struck some years ago; the house was not damaged, *but a workman standing near the rod was stunned.*

Thunderstorms.—Thunderstorms of unusual severity continue to occur in various parts of the kingdom, though the number of fatalities is not above the average. A fatal accident is reported from Coston, Leicestershire, where three men took refuge from a storm in a hovel; the building was soon afterwards struck by lightning and one man was killed. On Wednesday last week a large stack of straw near Sutton was set on fire by a lightning flash. On Thursday afternoon a violent thunderstorm passed over Richmond (Yorkshire) and district; during the storm the lightning entered a house through an attic window and did considerable damage to the interior. A flash simultaneously struck the roof and went to earth down the chimney, displacing slates and bricks in every direction. On Sunday Lancashire and the Midlands were visited by a storm of extraordinary severity. At Liverpool two houses were unroofed by lightning, and a number of cattle were killed in the surrounding district. At Preston the savings bank was struck, and a woman was seriously injured. At Blackburn a chimney was split in two, and some cattle were killed in the fields outside the town. At Great Harwood a mill was fired. At Accrington several mills were reported to have been "stopped by lightning." Ringley church, near Bolton, was fired by lightning and the gas ignited. A flagstaff on the Southport Pier was shattered by a flash, while the clock tower at the cemetery was also struck, the bell being thrown down. The tower of Didsbury National School, Manchester, was fired by lightning and burnt out, and at Pendleton the roof of a house was struck and collapsed. In Westmoreland the storm was equally destructive. At Greenhead, Milnthorpe, the lightning entered a building containing some prize animals, and four were killed. At Montrose, Brechin, and the villages near Dundee several houses were struck, and a large number of horses and cattle were killed. At Errol two houses were set on fire and destroyed, and two persons were injured. At Reay, about eleven miles from Thurso, a woman was killed by lightning. Considerable damage to life and property is also reported from Cheshire, Flintshire, and Lanarkshire.

Method of Displaying the Lines of Electrical Induction.—In the *Scientific American* Mr. R. W. Chapman, of the University of Adelaide, South Australia, describes the following pretty and instructive experiments:—"Some very pretty experiments may be made, and the lines of electrical induction between two electrified bodies may be shown extremely well, by the use of the fine white needle-like crystals of sulphate of quinine suspended in a good insulating liquid, such as pure turpentine. To perform the experiments, take a flat glass dish and pour in turpentine to the depth of about a quarter of an inch; sprinkle this with sulphate of quinine evenly distributed till the turpentine assumes a milky appearance. If now a brass ball, connected by a chain with an electrical machine, be placed at one end of the vessel, and another connected with earth at the other end of the vessel, on working the machine the crystals of quinine will become polarised and take up their positions end on end, forming very distinct curved lines between the balls in exactly the same way as iron filings form in lines of magnetic induction when sprinkled over a magnet. The symmetrical lines of white crystals when shown up by a dark background look extremely beautiful. We have here the basis for a set of experiments which may be diversified to an almost unlimited extent by varying the number and shapes of the electrified bodies placed in the turpentine. The fact that there is no electrical force within a hollow conductor may be very prettily shown by connecting both of the balls in the above experiment with the machine and placing in between them a large metal ring connected with earth. The curved lines are then very distinctly shown running from each ball to the ring, but within the ring the turpentine remains in the uniformly cloudy state in which it was initially, the crystals showing no disposition to place themselves end on end. The difference in the appearance of the quinine particles outside and inside the ring is very striking. If now a small third ball be connected with the machine and placed in the centre of the metal ring, the appearance of the turpentine within the ring is entirely changed, and the crystals form in straight radial lines from the centre to the circumference. By multiplying the number of the electrified balls, charging some positively and others negatively, the resulting lines of induction may be made very complicated, but, provided that there is a fair space between the balls, the lines are always distinctly and clearly mapped out by the crystals. It is an easy matter to obtain some very beautiful figures by symmetrical distributions of the electrified bodies. In making the experiments it is very necessary that the turpentine should be pure and dry, as a very slight amount of impurity is sufficient to destroy its powers as an insulating medium. Benzine will answer, and it possesses the additional advantage of not dissolving any of the quinine; while turpentine dissolves it to a slight extent, but its specific gravity is so small that the crystals fall to the bottom of the vessel almost at once, and adhere to it, so that they will not easily take up the lines unless the experimenter be sufficiently quick to electrify the balls before the particles reach the bottom. On the whole, turpentine I have found to give the most satisfactory results. After the crystals have once been electrified inductively in this way they appear to take up the lines much more easily a second time. It seems as though the molecules do not recover altogether from the effects of the electric strain."

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THE PARIS EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT).

May 29, 1889.

Of the exhibits which may be said to be complete that of the Société des Telephones de Zurich, in the Swiss Section, possesses several points of novelty and interest which are worthy of remark. Although by the name of the company one would imagine it to be wholly occupied with the construction of telephonic apparatus, an inspection of the exhibit proves this to be in fact a very small part of the company's sphere. Arc lamps, dynamos and electrical regulating appliances predominate, and bear the impress of considerable ingenuity. We give herewith a description of some of the apparatus exhibited by this company.

The ammeters and voltmeters are both constructed on the same design, which is fairly represented in Fig. 1. The needle (A) is of very thin, soft sheet iron, cut to the shape indicated, and pierced at intervals with holes. The free end enters more or less into the coil in action, and its movement is indicated by the pointer on the scale.

Figs. 2 to 6 illustrate parts of the automatic potential regulator. The action of this regulator is to vary the resistance in the circuit of the shunt coil of the field of a dynamo to compensate for any changes in the voltage at the machine terminals, whether caused by alterations in the load or speed. The solenoid in Fig. 2 is connected permanently to the two terminals of the machine, or the two points between which the potential is to be kept constant. The iron core of this solenoid is capable of moving freely within it, all friction against the sides being obviated by suspending the core with cords at either end. One end of the core is connected by a cord to a rocking lever, as shown, carrying at each end contacts dipping into mercury cups. Each contact is made by a platinum wire dipping into the mercury, and this wire is sealed in a small length of pointed glass tube fixed to the lever, the contact being continued by a flexible wire through the tube to the platinum, as shown. The mercury cups C C are of glass, and small iron plates dipping in the cups form the outside connection. The core is balanced and adjusted so that when the potential at the ends of the coil is normal it is not in a central position with regard to the coil, and therefore has play either way. The rocking lever is also in this case horizontal. It will be seen by the diagramatic connections in Fig. 6 that when the lever is horizontal the mercury-cup contacts shunt all current past the electro-magnets M M which actuate the regulating mechanism, but that when one contact is broken the current passes through one of the electro-magnets and attracts the central armature (Fig. 3) to that side. The mechanical arrangement for moving automatically a resistance switch backwards or forwards is effected in the following way:—The grooved pulley P (Fig. 3) is driven by a band off the dynamo or any countershafting connected to it. Fixed to and turning with the same shaft are two friction pulleys F F, while between them is the pulley A, which is only set in motion when it touches one of the running pulleys at its side, its direction of rotation depending on which pulley it touches. In Fig. 4 it will be seen that this pulley is connected to a long horizontal shaft carrying at its further end a worm; the switch carrying the toothed wheel into which this worm gears is shown removed in Fig. 5. This switch fits on over the upright spindle S (Fig. 4), and when so fixed is turned round slowly by the worm in either direction according to the direction of rotation of the shaft, and inserts or cuts out resistance accordingly. A coupling is inverted in the shaft so as to allow a small lateral play to the central pulley.

It will now be understood that the apparatus automatically adjusts the resistance either way according as to whether one electro-magnet or the other is operated. The arc lamps exhibited are designed with a worm feed motion. The shunt coil, by means of a circuit interrupter, actuates a paul and horizontal ratchet wheel, which rotates a vertical shaft. This shaft carries two worms, each acting on toothed wheels. The upper and lower carbons are each gripped between a pair of wheels, of which one is free to move and the other is actuated by the worm. The double rate of feed of the upper carbon is effected by employing a worm of double the pitch.

Six dynamos ranging from one to 40 horse-power are exhibited, and are built as indicated in Figs. 7 and 8. Simplicity of construction, external protection to the machine, as well as a good magnetic circuit, is secured by the form of field-magnets adopted. The machines are constructed to give 110 volts or 65 volts, the largest type shown developing 240 amperes at 110 volts and 750 revolutions, and weighing in all 5,900lb.

The same company also exhibit a distance water-level indicator, which depends for its action upon magneto currents. The usual float and counterpoise actuate a drum, which raises one of two levers, according to which way the drum is moving. The levers are weighted at their free ends, and when one is lifted, owing, say, to the float sinking and turning the drum one way, it is released by a detent after being lifted through a certain distance. In falling it causes the rapid rotation of the small armature of a magneto machine, and sends a current in such a direction that the indicator of the level is made to move back one degree. Similarly, the reverse action of the rising of the float causes the other lever to be lifted and let fall again, so that an opposite current is sent through the indicator, moving it forward one degree. Two of the smaller dynamos are coupled together to be run one as a motor and to drive the other as a dynamo for lighting the stand, but current is not yet supplied to it.

Electrical transmission of power will be well demonstrated. The Oerlikon Works, who have a fine exhibit, and are lighting by their system of arc lamps a portion of the Machinery Hall, have a transmission plant, in which the motor in another Section will develop 250 horse-power, and be used for driving a length of main shafting. The generator is a 300 horse-power four-pole dynamo, run by a compound condensing engine. These works will also run an exhibit of machine tools by electric motors from a 20 horse-power direct coupled engine and dynamo. A 60 horse-power combined engine and dynamo will run the lighting in the hall and supply current for motors. The switchboard will attract a great deal of attention. An automatic switch prevents injury to the machines on the transmission of power circuit by short-circuiting the field of the generator on any great excess of current occurring.

The Thomson-Houston International Electric Company are running an 80 horse-power dynamo generator at 500 volts potential, by which a 45 horse-power motor will be run in the American Section of the Agricultural Annexe to supply light and power. This company will also light the American Section, and will run a 35 arc lamp machine, a 500-light machine on the alternating-transformer system, and one of 300 lights on the alternating compensating system.

Further great interest will centre round the two systems of electric 10-ton cranes, now working, both as to their mechanical and electrical arrangements.

The first to be set to work was that under the control of Messrs. Bon and Lustreman, and is worked by a Gramme motor and dynamo, the latter being run by a Westinghouse engine in a shed some distance from the crane.

Paris, *June* 4, 1889.

The "Palais des Machines" and the so-called "Galerie de Thirty Mètres" have, since the 15th, been opened every night to the public, and the whole of the electrical illumination of the "Champ de Mars" may now be considered as complete. The same cannot be said of the lighting of the "Esplanade des Invalides," but after the trials of a few days ago it may be hoped that in the immediate future this interesting part of the Exhibition will also be able to be visited at night. The light is generally good, but it is not sufficient, and it will be necessary to increase its intensity at some points, especially in some parts of the side gardens and on the banks of the river. The Electrical Section is now very nearly finished. There are altogether over 600 exhibits, of which 480 are entered by French firms. The English electrical firms exhibiting are only 17 in number, whilst the abstention of the German electricians is complete.

The lighting of the line of the Boulevards from the Place de l'Opéra to the Place de la Concorde was commenced last Thursday; the light, furnished by 50 Thomson-Houston 2,000 candle-power arc lamps, is good, and very much appreciated by the public. They burn from half an hour after sunset up to

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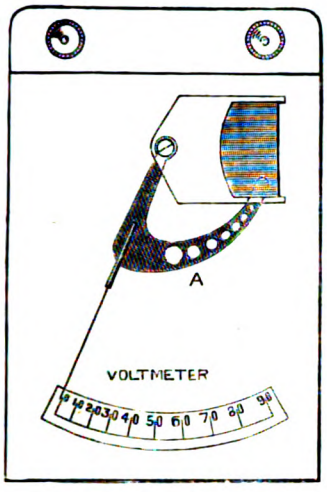

FIG. 1.

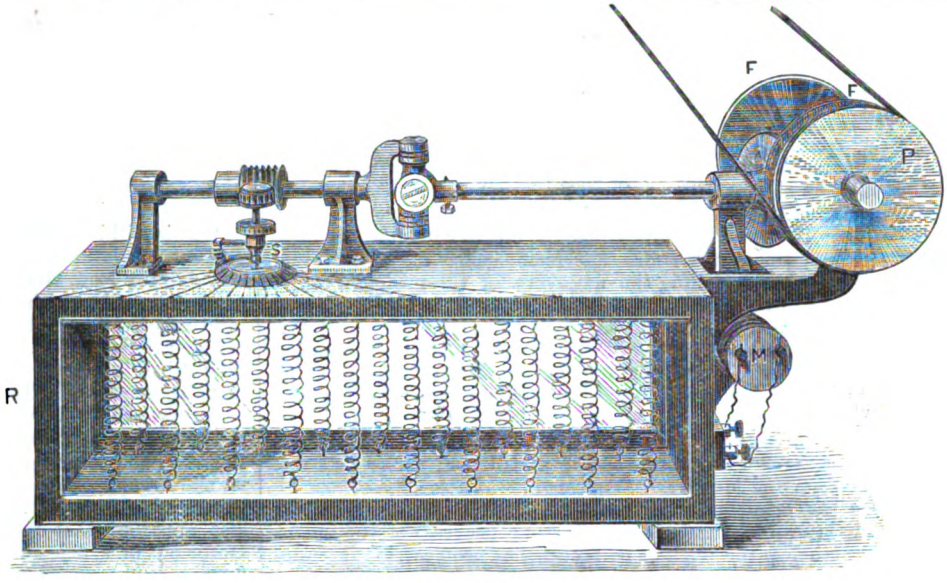

FIG. 4.

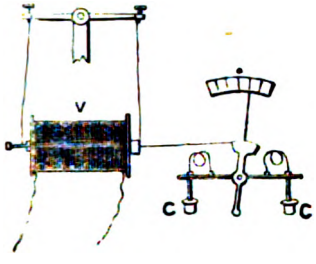

FIG. 2.

FIG. 5.
Resistance switch to fit over S in Fig. 4.

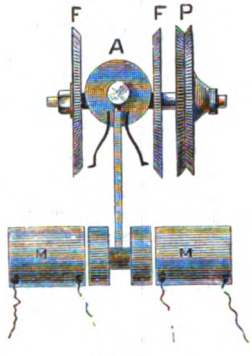

FIG 3.

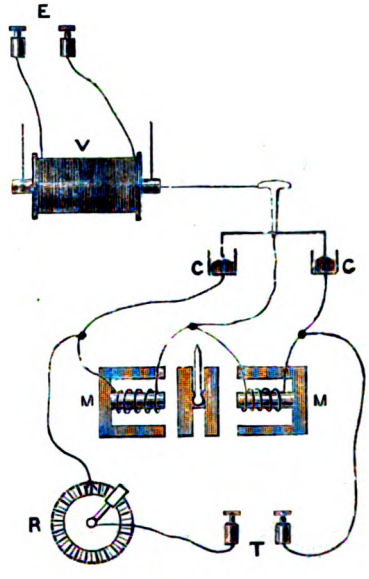

FIG. 6

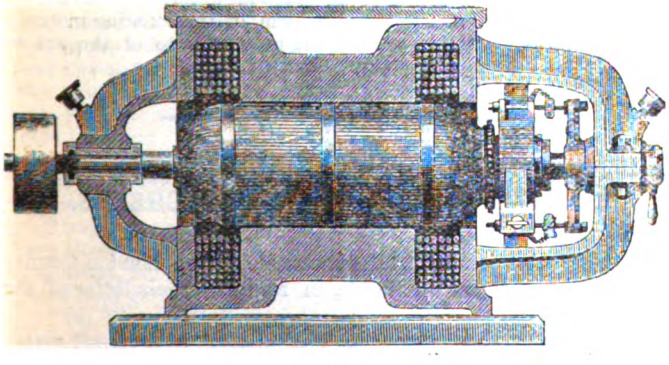

FIG. 7.

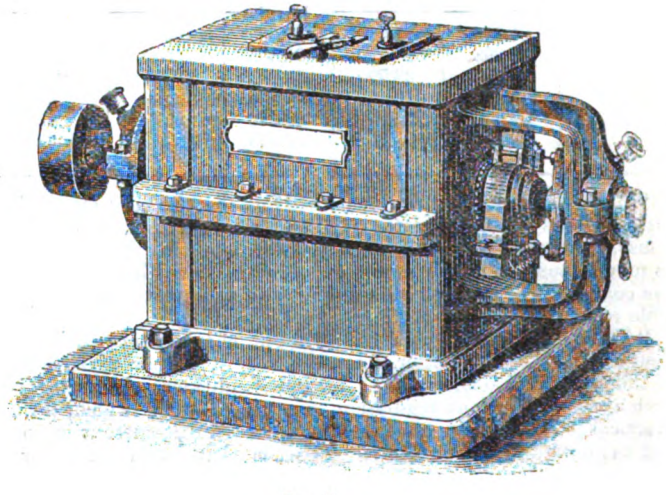

FIG. 8.

two in the morning. The rest of the Boulevards, from the Place de la République up to the Opéra, will have received the light by the time this letter is published, as well as the Rue St. Lazaire and the entrances to the Gare de l'Ouest. The Terminus Hôtel of this station was inaugurated a few days ago. It is entirely lighted by electricity. The motive power is furnished by two 150 horse-power (nominal) engines, but they are only provisional, and will be removed as soon as the Cie. du Secteur de la Place Clichy has its central station ready to furnish the current.

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MR NIKOLA TESLA ON THE GANZ ALTERNATING-CURRENT MOTORS.

Mr. N. Tesla has addressed the following letter to the Editor of the *Electrical World* of New York :—

"SIR: About a year ago I had the pleasure of bringing before the American Institute of Electrical Engineers the results of some of my work on alternate-current motors. . . By one of the most curious coincidences, however, Prof. Ferraris not only came independently to the same theoretical results, but in a manner identical almost to the smallest detail. Far from being disappointed at being prevented from calling the discovery of the principle exclusively my own, I have been excessively pleased to see my views, which I had formed and carried out long before, confirmed by this eminent man. In his able essay Prof. Ferraris omitted to mention various other ways of accomplishing similar results, some of which have later been indicated by O. B. Shallenberger, who some time before the publication of the results obtained by Prof. Ferraris and myself had utilised the principle in the construction of his now well-known alternate-current meter, and at a still later period by Prof. Elihu Thomson and Mr. M. J. Wightman.

"Since the original publications, for obvious reasons, little has been made known in regard to the further progress of the invention ; nevertheless the work of perfecting has been carried on indefatigably with all the intelligent help and means which a corporation almost unlimited in its resources could command, and marked progress has been made in every direction. It is therefore not surprising that many, unacquainted with this fact, in expressing their views as to the results obtained have grossly erred.

"In your issue of May 4 [*Electrician*, April 19, p. 671] I find a communication from the electricians of Ganz and Co., of Budapesth, relating to certain results observed in recent experiments with a novel form of alternate-current motor. I would have nothing to say in regard to this communication unless it were to sincerely congratulate these gentlemen on any good results which they may have obtained, but for an article, seemingly inspired by them, which appeared in the London *Electrical Review* of April 26, wherein certain erroneous views are endorsed and some radically false assertions made, which, though they may be quite unintentional, are such as to create prejudice and affect material interests.

"As to the results presented, they not only do not show anything extraordinary, but are, in fact, considerably below some figures obtained with my motors a long time ago. The main stress being laid upon the proposition between the apparent and real energy supplied, or perhaps more directly upon the ratio of the energy apparently supplied to and the real energy developed by the motor, I will here submit, with your permission, to your readers the results respectively arrived at by these gentlemen and myself.

Energy apparently supplied in watts.		Work performed in watts.		Ratio of the energy apparently supplied to the real energy developed.	
Ganz and Co.	Westinghouse Co.	Ganz and Co.	Westinghouse Co.	Ganz and Co.	Westinghouse Co.
18,000	21,840	11,000	17,595	0·611	0·805
24,200	30,295	14,600	25,365	0·603	0·836
29,800	43,624	22,700	36,915	0·761	0·846
...	56,800	...	48,675	...	0·856
...	67,500	...	59,440	..	0·88
...	79,100	...	67,365	...	0·851

"If we compare these figures we will find that the most favourable ratio in Ganz and Co.'s motor is 0·761, whereas in the Westinghouse, for about the same load, it is 0·836, while in other instances, as may be seen, it is still more favourable. Notwithstanding this, the conditions of the test were not such as to warrant the best possible results.

"The factors upon which the apparent energy is mainly dependent could have been better determined by a proper construction of the motor and observance of certain conditions. In fact, with such a motor a current regulation may be obtained which, for all practical purposes, is as good as that of the direct-current motors, and the only disadvantage, if it be one, is that when the motor is running without load the apparent energy cannot be reduced quite as low as might be desirable. For instance, in the case of this motor the smallest amount of apparent energy was about 3,000 watts, which is certainly not very much for a machine capable of developing 90 horse-power of work ; besides, the amount could have been reduced very likely to 2,000 watts or less.

"On the other hand, these motors possess the beautiful feature of maintaining an absolutely constant speed no matter how the load may vary. This feature may be illustrated best by the following experiment performed with this motor. The motor was run empty, and a load of about 100 horse-power, far exceeding the normal load, was thrown on suddenly. Both armatures of the motor and generator were seen to stop for an instant, the belts slipping over the pulleys, whereupon both came up to the normal speed with the full load, not having been thrown out of synchronism. The experiment could be repeated any number of times. In some cases, the driving power being sufficient, I have been enabled to throw on a load exceeding eight to nine times that which the motor was designed to carry, without affecting the speed in the least.

"This will be easily understood from the manner in which the current regulation is effected. Assuming the motor to be running without any load, the poles of the armature and field have a certain relative position which is that of the highest self-induction or counter electromotive force. If the load be thrown on, the poles are made to recede ; the self-induction or counter electromotive force is thereby diminished and more current passed through the stationary or movable armature coils. This regulation is very different from that of a direct-current motor. In the latter the current is varied by the motor losing a certain number of revolutions in proportion to the load, and the regulation would be impossible if the speed would be maintained constant ; here the whole regulation is practically effected during a fraction of one revolution only. From this it is also apparent that it is a practical impossibility to throw such a motor out of synchronism, as the whole work must be done in an instant, it being evident that if the load is not sufficient to make a motor lose a fraction of the first revolution it will not be able to do so in the succeeding revolutions. As to the efficiency of these motors, it is perfectly practicable to obtain 94 to 95 per cent.

"The results above given were obtained on a three-wire system. The same motor has been started and operated on two wires in a variety of ways, and although it was not capable of performing quite as much work as on three wires, up to about 60 horse-power it gave results practically the same as those above mentioned. In fairness to the electricians of Ganz and Co., I must state here that the speed of this motor was higher than that used in their experiments, it being about 1,500. I cannot make due allowance for this difference, as the diameter of the armature and other particulars of the Ganz and Co. motor were not given.

"The motor tested had a weight of about 5,000lb. From this it will be seen that the performance even on two wires was quite equal to that of the best direct-current motors. The motor being of a synchronous type, it might be implied that it was not capable of starting. On the contrary, however, it had a considerable torque on the start and was capable of starting under fair load.

"In the article above referred to the assertion is made that the weight of such alternate-current motor for a given capacity is 'several times' larger than that of a direct-current motor. In answer to this I will state here that we have motors which with a weight of about 850lb. develop 10 horse-power with an efficiency of very nearly 90 per cent., and the spectacle of a direct-current motor weighing, say, 200 to 300lb. and performing the same work would be very gratifying for me to behold. The motor which I have just mentioned had no commutator or brushes of any kind, nor did it require any direct current.

"Finally, in order to refute various assertions made at random, principally in the foreign papers, I will take the liberty of calling to the attention of the critics the fact that since the discovery of the principle several types of motors have been perfected, and of entirely different characteristics, each suited for a special kind of work, so that while one may be preferable on account of its ideal simplicity another might be more efficient. It is evidently impossible to unite all imaginable advantages in one form, and it is equally unfair and unreasonable to judge all different forms according to a common standard. Which form of the existing moters is best time will show ; but even in the present state of the art we are enabled to satisfy any possible demand in practice."

THE LONDON COUNTY COUNCIL AND THE METROPOLITAN ELECTRIC LIGHTING SCHEMES.

The following is the letter addressed by the London County Council to the Board of Trade, in reply to their letter of the 18th May :—

"SIR: The Council has under consideration your letter of 13th March last, in which, referring to the electric lighting schemes of the present Session, you express the wish of the Board of Trade to be furnished with any observations which the Council may have to offer upon the large and very important question of the future of electric lighting in London, and you refer especially to two questions of principle which have arisen in relation to the matter, viz. :—(1) What should be the extent and nature of the area to be granted ? and (2) Should or should not concurrent powers be granted

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to two or more companies within the same area? The Council has also considered the further letter from the Board of Trade, dated 18th of May, forwarding copies of a report by Major Marindin, R.E., on the result of his inquiry into the applications for Provisional Orders and Licenses under the Electric Lighting Acts, 1882 and 1888, as well as into the subject matter of the Bill introduced into the House of Commons by the Metropolitan Electric Supply Company.

"The Council has directed me to submit the following suggestions and observations for the consideration of the Board of Trade when dealing with the electric lighting schemes affecting the county of London.

"The Council agrees that extensive areas may properly be granted to companies when their financial and technical means of carrying out the powers entrusted to them are of a satisfactory character, and accepts generally the recommendations of the report as r gards the districts to be allotted to the several companies.

"The Council considers that in the interest of the public competition is desirable under proper restriction.

"The Council is not prepared to offer any opinion or suggestion with reference to the scientific or technical portion of the report, but desires to express its full concurrence with the recommendation in Major Marindin's Report that a company supplying a large area without a reserve of current should be required to provide duplicate sets of generating machinery in separate buildings and duplicate sets of mains, in order to secure a proper and continuous supply in case of a breakdown of machinery or other default; and, further, that every possible means should be taken for guarding against danger to the public from currents of high tension.

"The Council concurs in Major Marindin's suggestion (2) that certain streets should be scheduled in each district of the compulsory laying of mains, and that the supply in the remainder of the area should be made compulsory, upon requisition of consumers, on fair and reasonable conditions; and suggests that in case of such supply not being afforded after a sufficient interval of time, the Order should be revoked as regards the whole of the parish or district in which such default occurs. It appears to the Council that without such a provision being made a company might be in a position to supply those parts of a parish or district where there was a good demand, and to leave unsupplied those parts of the area in which the demand was limited. The Council further suggests that the companies should be required, in all streets where mains are laid, to bring the supply at their own cost to the consumers' premises.

"The Council concurs in the suggestion (6) in Major Marindin's report that wherever a company now supplying a district by means of overhead wires is granted an Order for such area the company should be placed under statutory obligation to remove these overhead wires; and the Council suggests that it should be an indispensable condition of the granting of any application for an Order or License that, in the area referred to therein, all wires and mains should be laid underground.

"With reference to Clause 55 of the London Company's Order, which would enable the company to supply electricity to a Vestry or District Board for the latter to retail to consumers, the Council considers the expediency of granting such a power to be doubtful, and would suggest that, if allowed, a provision should be inserted that the power given by the clause shall in no case be acted upon without the consent of the Council having been first obtained.

"The Council also submits the following general suggestions applicable to all the Orders and Licenses, namely:—

"(*a*) That the terms and conditions of all Orders or Licenses granted should be as nearly as possible identical.

"(*b*) That companies should be required not only to make use, with the consent of the Council, of subways now made, or which may hereafter be constructed, in streets where mains are to be laid, but to pay a fair rent for such use, and further, that in case of subways being in future made in streets where wires are already laid, the companies should be under an obligation to remove the wires into such subways and to pay a rent for the use of them, a reasonable time (say three years) free of rent being allowed as a set-off to the cost of such removal. That the power to make subways in the London streets should be vested in the Council, and not in the local authorities of the several districts.

"(*c*) That provision should be made to prevent the opening of any thoroughfare in the county of London for the purpose of laying mains, &c., until the consent in writing of the Council shall have been given to such opening.

"(*d*) That provision should be made for exempting the Council and the Vestries and District Boards from liability in respect of any damage which may be done to mains, &c., in carrying out works of repair or improvement in streets or roads, or from the use of steam rollers in the execution of such works.

with main or local sewers, or with the proper access to them, without the consent of the authorities in which such sewers are vested; and that plans of works which would interfere with sewers in any way should be submitted for the approval of such authorities before the works are begun.

"(*e*) That provision should be made for preventing interference

"(*f*) That, in view of future possible reduction in the cost of production which may be made as the result of experience and invention, there should be a provision that the maximum price of eightpence per Board of Trade unit proposed to be adopted shall be subject to revision at the end of seven years; and that in order to insure healthy competition between the companies during that period—(1) No amalgamation or working agreement between companies should be permitted without the consent of the Council, and (2) Power should be given to the Council, at the request of a Vestry or District Board, or on the requisition of inhabitants in any street or district, and with the consent of the company interested, to extend the area of such company to such street or district without the necessity of obtaining another Order. That clauses should be inserted providing for the application at the end of the seven years of a sliding scale of price and dividend, on the basis of a dividend of 8 per cent., leaving the initial price and arrangement of the scale to be determined at the expiration of the term of seven years.

"That the minimum charge for supply should be fixed as low as possible, and that should such minimum be fixed at £1 per quarter or over, it should be reckoned by the year and not by the quarter, because of the irregular requirements of the consumer at different seasons of the year.

"(*g*) That for the purposes of purchase by a public authority, any additions made to the area of supply of any company shall be taken to be part of the original area granted to such company, and that the powers over the additional area shall terminate at the same time as those over the original area, unless at the time the additional powers are granted to the company it shall be expressly stated to the contrary.

"The Council considers it would be to the advantage alike of the public and the companies that there should be one uniform system of regulation and control throughout the entire area of London. The necessity of this was forcibly illustrated by the very varied and in many respects inconsistent objections and requirements of the different Vestries and District Boards in regard to the proposed Orders, and by the complication and difficulty occasioned thereby. The Council is of opinion that, as the representative governing body of the whole of London, it should be appointed the controlling authority. It would always receive and give the fullest consideration to the representations of any local body on questions affecting its particular interests. It would remind the Board of Trade that the main roads throughout the Metropolis will shortly be under the jurisdiction of the Council, and should any general system of subways be hereafter resolved upon, such system will also be under its control. The Council considers also that it should be the authority to whom should be given the power of purchase in all cases at the expiration of the specified period; it would be manifestly impossible for any single Vestry or District Board to purchase a large undertaking supplying many parishes, such as that of the London or the Metropolitan Company. The Council would further suggest that if it is made the controlling authority it should be empowered to discharge the following duties, viz.:—

"Inspection of lines and works.

"Testing current.

"Testing and certifying meters.

"Taking proceedings for imposition of penalties or forfeiture in cases of default, as provided in the Order.

"And in order to carry out the work of testing, it should be made obligatory on the companies to provide and maintain sufficient testing stations and proper and efficient testing apparatus.

"The Council, in view of the fact that some companies have been, and are now, supplying electricity by overhead wires, without statutory powers, and being convinced of the undesirability of allowing this to be continued, would venture to suggest that in any further legislation on electric lighting the supply of electricity in any district, before obtaining statutory powers for such district, should be prohibited under penalty.

"The Council, in submitting the above suggestions, is animated by a desire to facilitate the working of the companies' undertakings in the various areas to be allotted to them, and, at the same time to insure that the interests of the public are properly guarded; and the Council thus submits its views in the full assurance that they will receive due consideration from the Board of Trade.

"Some of the Orders will affect the bridges, embankments, and other works under the jurisdiction of the Council, but the Council reserves any expression of opinion upon the manner in which its interests should be protected, as also upon other general matters of detail, until it shall have received the copy of the Model Order referred to in the letter from the Board of Trade on the 18th of May.

"I am, Sir, your obedient Servant,
"H. De la Hooke, Clerk of the Council.

"The Assistant Secretary, Railway Department,
"Board of Trade."

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LEGAL INTELLIGENCE.

King, Brown and Co. *v.* The Anglo-American Brush Electric Light Corporation (Limited).

(Concluded from page 93.)

THE DEFENDERS' ARGUMENT.

On the termination of the case for the Pursuers on Thursday, the 23rd ult., the Argument for the Defenders was commenced, and did not conclude till Friday, the 24th.

Mr. JAMESON, in the absence in London of the Dean of Faculty, addressed the Court on behalf of the defenders. He said he should endeavour to follow as clearly as he could the order taken by his learned friend in his very clear and lucid speech, if he might be allowed to use that language.

LORD TRAYNER: I think it is highly deserved.

Mr. JAMESON said that of course he did not wish to say anything that might appear—

LORD TRAYNER: Patronising (laughter).

Mr. JAMESON: Yes. Mr. Murray had put the case in an order which he could not do better than follow, and also be more convenient for his lordship. The first question was about the commutators, and in regard to that matter it was, in the first place, necessary that they should clearly understand that that invention, so far as it related to the commutator, was not an invention of a new article. Commutators were known and used long before Brush. It was not a new application of electrical principles, nor was it a proper electrical invention at all. It was a pure invention in the mechanical appliance or form of commutator, and, as they submitted, an invention both of utility and novelty. Prof. Silvanus Thompson put it very well when he said, "They are claims for useful mechanical details and combinations of details." That commutator was exceedingly useful and novel. In the first place there was a large insulating hub—not a mere ebonite collar, as in the other case—between the metal of the shaft and the metal of the commutator, which had the result of effectually insulating every one of the wires from the shaft, and insulating them from one another. Then upon the top of that insulating hub they had sub-segments of a particular model. All these were brought in close electrical connections with the wires which came up under each of them and maintained the electrical connection. These were screwed firmly on to the hub, not being intended to be removed, and the screw was of a very peculiar form, which might be said to be all head. The result of that was that although some of the wires wore, there was always a head to keep the wearing segments on the sub-segments. In short, it had a head as long as there is any wearing segment to hold down. The head commenced immediately outside of the sub-segments. That was a very considerable advantage, because however far it was worn away, all that was done was to make a catch with a screwdriver and unscrew the screw. Taking the invention as a whole, he submitted that it was an invention of great utility and novelty. The learned counsel then proceeded at considerable length to deal with this part of the patent.

FRIDAY.

Mr. JAMESON resumed his argument on Friday. He maintained that Varley's commutator was not an anticipation of Brush's because the wearing segments were not detachably attached.

LORD TRAYNER: The case about the commutator stands thus. The Brush and the Varley commutators were quite common; the only question is, is the commutator described in your provisional specification, and as finally claimed—assuming it to be well known—mechanically as you put it or electrically as they put it, different from the commutator in use?

Mr. JAMESON said that of course he held it to be mechanically different.

LORD TRAYNER: But was yours mechanically different in such a way as to make it patentable?

Mr. JAMESON pointed out that there were the wearing pieces screwed on, and the wearing segments extending to and filling up the gap in the next ring, which were also the wearing segments of that ring; the cylindricity, the peculiar form of the screw, and the putting in of the screws from the outside so as to make them easily detachable; and the peculiar form of the hub. All these things would make it patentable.

He then turned to the more important question of the compound-winding. While it was true, as his learned friend had said, that possibly Brush no more than Varley—supposing Varley had any clear idea on the subject—knew what a valuable application was to be afterwards made of compound-winding, yet the specifications were totally different in one way. Brush, however, knew what he was about, because, although he was not seeking for what, strictly speaking, was known now as constant-potential, yet he was seeking a self-regulating machine, and he described it with admirable distinctness, and displayed it in drawings which "he who runs may read."

LORD TRAYNER: I do not know about "he who runs may read;" but I have looked at it a long time, and I cannot make much of it.

Mr. JAMESON said the provisions showed the compound-winding with a thick and a thin wire, and they also showed to a great extent the proportion and size of these wires. Brush had found that what he was really trying to get to was a machine which could adjust itself to varying loads, and could do so automatically. To do this it was necessary to have the mechanism of the magnet maintained at something like constant power, so that they might produce electricity sufficient to do their work. He might have thought more about currents than about potential, but be that as it might, his object certainly was to procure a machine which, as he said, would have the power constantly maintained. Every one of the witnesses admitted that constant potential was not a thing that could be the subject of a patent, nor could they obtain a patent for a machine which in all circumstances would give constant potential, because constant potential depended upon the work to be done, the speed at which it went, the way it was done, and a number of things of that sort. Now there could be no doubt that Brush's machine—and this was practically admitted by the pursuers' witnesses—did produce constant potential in certain cases.

LORD TRAYNER: There is no doubt Brush's machine is a very good one, and it has been very valuable, but the question is whether it was anticipated.

Mr. JAMESON said his Lordship had been invited to compare Varley's specification with Brush's as to the disclosure concerning which machine could be made upon the footing that neither of them knew, and that there was not in the specification set forth any object to be attained by a machine of this kind. Now that was not so. It was so with regard to Varley. Varley never made it one of his objects, and he did not claim it. Brush, on the other hand, set out with his object, not to obtain constant potential but to patent something that would lead to it—some machine giving data of a certain kind. His object was to get a self-regulating machine, and he described how that was to be done, and set out in drawings how he wished it to be carried out. Therefore, in comparing one sentence of Brush's specification with one of Varley's, they must keep in mind that Brush's specification was altogether occupied in describing a machine with magnets wound in this way for a particular object, while in Varley's specification there was no indication of what he was trying to get at, and there were lots of indications to a contrary effect. These indications were misleading, and would take a person away from the sense of the words of the specification, assuming he was trying to describe compound-winding. It would not do to refer for the purpose of comparison to the specification without showing that Varley's alleged anticipation of Brush referred to what Brush said in describing his machine. Brush had an object before him which he set forth and which he proposed to accomplish in a well-defined way, aided by drawings which he set out. Turning to Varley's specification of 1876, he referred to the lines on page 8—"Part of the electricity developed by the machine is diverted to maintain the magnetism of the magnets, and the remaining portion is used to produce the electric light." The diversion of the magnetism must be to one of two things—either to shunt or to separate excitation within the machine, such as they had in Wylde's machine and others. As Sir Wm. Thomson had said in his evidence, the statement "remaining portion was used to produce the electric light" meant that it was used only to produce electric light. That was a fair interpretation of the sentence in the specification as it stood.

LORD TRAYNER said the remaining portion might return for some purpose.

Mr. JAMESON held that there was no indication of that, and that an operative knowing nothing about the shunt—which was really unknown at that time—would naturally think only of what other methods were in vogue. Varley's statement that there were several well-known modes of using the remaining portion of the electricity answered exactly to what was accomplished by Wylde and others. He therefore submitted that an ordinary intelligent electrical workman at the date of Varley's patent would be most likely to suppose from this part of the specification that the electricity would be developed by the machine, and not obtained by bifurcation in the way the shunt-series operation was. Alternatively he submitted that taking this along with the rest of the specification there was really such a mass of incongruities that no workman would be led to wind a machine in this way or think of doing so. There was no well-known way of diverting the current by bifurcation. Shunt was not known in these days. It was so little known that Hadden claimed it in his specification. The well-known way of diverting the electricity referred to by Varley was not bifurcation at all, but by having a separate coil running round the magnet brought from a separate part of the machine. It was simply a portion of the machine-power cut off and sent straight to maintain the magnet while the rest of the electricity went the other way. Of course there could be no anticipation of compound-winding, even supposing there were two windings on the field magnet, for the one was series and the other was a winding led from a different part of the machine altogether. In support of his contention Mr. Jameson referred in detail to the evidence of Sir William Thomson, whose verdict on Varley's specification as a whole was that it did not disclose a series-shunt machine as described by Hadden, and that any electrical workman in 1876 reading Varley's specification would not have had disclosed to him a system of series-shunt winding. That was the deliberate opinion of probably the greatest electrician of the day, who had followed all the changes and improvements in electricity. This was of the very highest importance in this case, in which there was certainly a very heavy onus on the pursuers, for admittedly until Crompton's case there was no question of Brush having been the first person to disclose compound winding. Then Varley came forward with his specification, and said he disclosed this thing long ago.

LORD TRAYNER: There is always some point at which the question of an anticipation is brought forward.

Mr. JAMESON: Yes, but it is generally an early point.

LORD TRAYNER: Not until it is somebody's interest to fight it, such as King, Brown and Co.

Mr. JAMESON said that nobody ever heard of Varley's anticipation before Crompton's case. The extraordinary thing was that moving in electrical circles he never divulged or disclosed or claimed anything in connection with compound-winding until this case of Crompton's arose, and then he had some negotiations, after the thing was done, with the Brush Electric Light Company. Counsel did not lay much stress upon that, for no doubt Varley tried to make the best of his position. Some of the witnesses, other than Sir Wm. Thomson, said that the first two and a-half

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lines of Varley's specification if they described any portion of the shunt machine described simple shunt and nothing more.

LORD TRAYNER: If anybody goes that length he goes a good way, because if these lines describe shunt they undoubtedly describe a system of bifurcation. Yet Prof. Silvanus Thompson says he cannot find any suggestion of bifurcation in these three lines at all.

Mr. JAMESON said that was because the idea at that time was excluded, for there was no bifurcation known at the time in that electrical world. Of course taking off the current was quite well known in telegraphy. Then another point Sir William Thomson made, and Prof. Silvanus Thompson and other witnesses agreed with, was that the idea of storing the magnetism was erroneous. They had good reason to believe from these things that Varley was not attempting to describe compound-winding. There were a great number of other absurdities in this specification.

LORD TRAYNER: Is it material how many absurdities there are if you find shunt-series described and disclosed? If you find series-shunt disclosed then these absurdities are of no moment.

Mr. JAMESON said that the series-shunt as described here was a part of the machine and nothing more, and it would never occur to a workman who took this specification as a whole to fix upon this as describing a new mode of winding.

LORD TRAYNER: The workman in whose hands the specification was put in 1876 made a machine which was of compound-winding.

Mr. JAMESON: Yes; but under Varley's instructions.

LORD TRAYNER: No doubt; but that showed that Varley knew what he was doing.

Mr. JAMESON said that if they were to believe that this machine was made expressly for this purpose it was compound-winding; but there was this observation to be made, that it was an experimental machine. It might be coupled up in many different ways, and had ten terminals.

LORD TRAYNER: Although it had ten terminals it was compound-winding all the same.

Mr. JAMESON: It had double winding, but it was not series-shunt.

LORD TRAYNER: In what other machine have you double winding—wires of different resistance?

Mr. JAMESON: I do not know of any.

LORD TRAYNER: You may have a machine with two coils of wire.

Mr. JAMESON: You may have them quite well on the principle of different excitation.

LORD TRAYNER: Let me see in the evidence anything that indicates that in a machine which was series, and had separate excitation within itself, that the coils of wire passing round the magnets were of different sizes.

Mr. JAMESON said he did not think there was such a thing in the evidence. A workman reading Varley's specification might quite well think there were good reasons for having that wire for the excitation of the magnets of less resistance. It might maintain the electricity longer or retain the residual electricity longer, and it might have a more permanent effect with currents passing at so many times. Curiously enough, what Cromwell Varley foreshadowed was a coil of wire closed in itself all round the magnet to detain a certain amount of electricity or magnetism in the coils in which it was wound. That was a case of two coils of different resistance. There was such a hazy notion of the thing in Varley's mind that he was not likely to describe it very clearly in the specification.

LORD TRAYNER: The question is whether you have in this hazy expression a point which struck at series-shunt by the use of two wires of separate resistance round some magnet, the principle of which was not known at the time but is known now.

Mr. JAMESON maintained that there was no disclosure of a purpose in Varley's specification. He appreciated the point about greater resistance, which showed there was in Varley's mind some notion of the kind; but the suggestion, although it seemed very important to people now, would not necessarily to a workman at that date suggest that the purpose of having greater or less resistance was that of self-regulation.

LORD TRAYNER: Would it not suggest something of the kind to a workman if he found two wires of greater or less resistance?

Mr. JAMESON: He would find so many absurd things in the specification that he would think it was another conundrum.

LORD TRAYNER: And, like the American, he would give it up (laughter). But there was Siebe and Gorman's machine.

Mr. JAMESON: They were partners with Varley.

LORD TRAYNER: That machine showed he knew what he wanted.

Mr. JAMESON: Yes; he had a notion in his head about it.

LORD TRAYNER: If that lamp was used on Varley's machine it must have been in series-shunt. The only time it was used was in connection with the lamp, and therefore the only time it was used was as series-shunt.

Mr. JAMESON: I doubt if it was.

LORD TRAYNER: When it was used it was used with the lamp. Your own evidence shows that it must have been used as series-shunt.

Mr. JAMESON: It might have been used in the series without shunt coupling. There is one thing certain, that the use was so unsatisfactory that they dropped it.

LORD TRAYNER: Of course, Mr. Jameson, although my observations appear to be adverse to you they are simply made for the purpose of obtaining information. I have no opinion in the case the one way or the other.

Mr. JAMESON proceeded to say that it was proved that when the lamp was out it attracted keys and other things. That would be accounted for by the residual magnetism. There was nothing to show that at the time the lamp was there it was not coupled up so as to produce the magnetism of the magnets by a separate excitation arrangement. Throughout the whole specification Varley was trying to show how his great idea of these bobbins split up into groups could be applied. The same arrangement would take place with regard to the storing up of the electricity which he claimed as his invention. As pointed out by Sir Wm. Thomson, Prof. Silvanus Thompson, and Prof. Perry, his specification was full of inconsistencies. It was founded on an erroneous idea, and was in practice a complete failure, the lamp never having been put in use. Even supposing that Varley made his machine in series-shunt, and intended coupling it up in that way, that of course would be no disclosure of series-shunt so far as the specification was concerned unless in the specification he put the public in as good a position as he himself was in with regard to information. As to the models which the four witnesses for the pursuer said they made from Varley's specification, he contended that they would have required to know how much these witnesses had heard about electricity. Immense progress had been made since 1876 in electricity, and it was impossible to judge between these witnesses and the workmen of thirteen years ago.

LORD TRAYNER: If you take the evidence as true the two lads who were examined had no information of any special kind, and yet from the specification they made these models, which were said by your witnesses to represent series-shunt winding.

Mr. JAMESON proceeded to point out that Varley's machine was proved to be merely an experimental machine, and he referred his Lordship to several cases to show that if a machine was made and used merely experimentally and then thrown aside and not used that would not be held to be anticipation of another machine that was brought forward. He maintained that it could not for a moment be held that, for purposes of practical utility, Varley's patent had anticipated that of Brush.

LORD TRAYNER: There is also this difference in your favour, that whatever Varley's purpose was in mentioning double-winding he made no claim for it.

Mr. JAMESON: That is a very important point.

LORD TRAYNER: But the question is whether Varley described in his specification and had in view such a machine as would, if money had been expended on it, and it had been put into the market, have done just what Brush's machine is doing now.

Mr. JAMESON: I can say nothing further on that point than this, that after fair and sufficient trial, after being exhibited to people interested in the matter, and a deal of money having been expended on it, the machine was not taken up as being a success.

Mr. JAMESON proceeded to argue that the fact of Varley's machine having been thrown aside until it was disinterred for the Crompton case was a very strong presumption that it was a merely experimental machine. He maintained that the Brush commutator was an important mechanical improvement, and that it was sufficiently disclosed in the provisional specification. Varley's patent did not disclose compound-winding necessarily at all; but whether that was so or not, it did not disclose it in such a way as to constitute an anticipation of Brush's patent, which described compound-winding much more lucidly and with much greater detail for the instruction of workmen. With regard to the use of Varley's machine, he held that it was just experimental, and the best test of that was that it had never been heard of since. It was quite against the policy of the patent law, and of the authorities which he had quoted to his Lordship, to hold that such a machine could constitute a public use so as to invalidate a subsequent patent.

LORD TRAYNER: I am extremely obliged to you, Mr. Jameson, for your very able argument, which has made a great impression on my mind.

His LORDSHIP then took the case to avizandum.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, June 7th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Recent Researches into the Origin and Age of the Highlands of Scotland and the West of Ireland." By ARCHIBALD GEIKIE, F.R.S.

SATURDAY, June 8th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Idealism and Experience in Philosophy and Literature." By Prof. W. KNIGHT, LL.D.

PHYSICAL SOCIETY.

3 p.m. "On a Method of Suppressing Sparking in Electric Currents." By Prof. S. P. THOMPSON, D.Sc. "On a Shunt Transformer." By Mr. E. W. SMITH. Notes on Geometrical Optics:—(1) "On the Deduction of the Elementary Theory of Mirrors and Lenses from Wave Principles." (2) "On a Dioptic Spherometer." (3) "On the Formula of the Lenticular Mirror." (4) "On the Use of the Focal Circle in Mirror and Lens Problems." By Prof. S. P. THOMPSON, D.Sc. "On the Use of the Biquartz." By A. W. WARD.

TUESDAY, June 11th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Some Recent Biological Discoveries." By Prof. E. RAY LANKESTER, M.A., F.R.S.

WEDNESDAY, June 12th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. "Description of a New Species of Megalotrocha from Brisbane." By V. Gimson Thorpe, R.N.

THURSDAY, June 13th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture "Chemical Affinity." By Prof. DEWAR, M.A. F.R.S.

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The Electrician.

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A PROFESSORIAL ATTACK UPON THE BOARD OF TRADE REPORT.

Prof. SILVANUS THOMPSON has written to *The Times* a letter expressing feelings of "astonishment and regret" at the issue of the Board of Trade Inquiry. Prof. THOMPSON feels that "conclusions so illogical, so obviously one-sided, and so inimical to the interests of a large section of the community" are indeed to be deplored.

Inasmuch as this view of the matter differs somewhat widely from that to which we have already given expression, we have felt it desirable to again go over the grounds upon which our first impression was based. Having done this, as we trust, with due candour, we venture now to say that there is no such occasion for alarm and dismay as the learned Professor would have us believe, whilst at the same time we feel indebted to Prof. THOMPSON for giving us a suitable opportunity to call attention to some features of the report which are of great importance to the industry at large.

Let us first see what are the grounds on which we are called upon to pronounce Major MARINDIN'S proposals "illogical, lame, and unfair," and to join with Prof. THOMPSON in implor-

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ing the London County Council to refuse their august sanction to the scheme. The gist of Prof. THOMPSON's complaint may be gathered from the following sentences, which we bring together from different paragraphs of his letter:—

(1.) "Is it fair or right that in the only districts where absolute monopolies are granted they should be granted to alternate-current systems? . . ."

(2.) "Does it not seem monstrous that the whole of the proposals of the Electric Power Storage Company, one of the competing applicants, who asked not for a monopoly for themselves, but for fair field to compete with the alternating-current companies, should by the Board of Trade's action be ruled out on a mere technicality, which could have been set right at Somerset House for a few half-crowns?"

(3.) The third ground of indictment is that "Mr. CALCRAFT seems tacitly to have adopted the notorious [why notorious?] creed of the London Electric Supply Company . . . . and in so doing he not merely abandons, but deliberately inverts, the sound principle laid down in his own report, in 1883, that so long as a company in a district does its duty to the public, so long a competitor is not to be admitted."

Let us consider these objections in order. In the first it is implicitly stated that in certain districts an "absolute monopoly" has been conferred, and that in every such case it is an alternate-current system which has thus been favoured. We must, however, be permitted to express some genuine surprise that so acute and careful a critic as Prof. THOMPSON should have been led to overstate his case in so glaring a manner. Surely it is evident enough that the very ruling which furnishes ground for one of his complaints renders it untrue to say that any "absolute monopoly" has been conferred on any one. The examples which have just been afforded in the case of the Chelsea Order and the St. James' License are sufficient to show that on due cause being alleged the Board will at any time lend their ear to any suitable applicant for powers within the districts which may happen for the time being to rest in the hands of any single Company. "Absolute monopoly" has been ruled out of existence. It is, however, still more to the point to observe that (with the exception referred to in the second of the grievances enumerated above, and with which we shall presently deal) in the territories where alternate-current companies hold for the present undivided sway no one else has so far sought to share their responsibility. In the City, in Clerkenwell, in Holborn, in Bloomsbury, in Southwark, Lambeth, Bermondsey, and Rotherhithe there were no other applicants. To find fault with Major MARINDIN on this score is, therefore, so far as these districts are concerned, simply absurd.

There remains, however, the important district of the Strand, and here we come upon the next clause of the indictment. In this quarter the applications, both of the London Electric Supply and of the Electrical Power Storage Company, were refused in favour of the Metropolitan. The London Company has obtained ample compensation elsewhere, but the Electrical Power Storage Company has lost its entire case. If it were true, as Prof. THOMPSON alleges—we would rather say, if it were the *whole* truth—that this decision is based upon a "mere technicality" relating to the form in which the Company had first been registered, then, although we could not admit that the edict was properly characterised as "monstrous," we might easily think it needlessly stringent. But what are the facts? Referring to the report (*The Electrician*, May 24, p. 59), we shall find that in spite of Prof. THOMPSON's indignation the INSPECTOR carefully abstained from any definite pronouncement upon the point now in question. His decision was based upon a question of principle of far higher importance than this. "*However this may be*," is the language of the report (and it is of such importance that we transcribe the passage at length), "it is perfectly clear from the evidence of the Manager of the Company that the Company does not intend to exercise the powers which would be granted by the Order, but to transfer them to some other persons. I have no doubt that these persons are perfectly willing and competent to carry out the powers and obligations of the Order, but I submit that it would be quite contrary to practice to grant an Order to any but a properly-constituted company, proved to be in a position to act under it; and as this has not been done I cannot recommend that the Order be granted."

It will thus be seen that had Major MARINDIN reported in favour of this application he would virtually have thrown open the door to a class of speculation which most of our readers will admit to be extremely undesirable. As to the *bonâ fides* of the Electrical Power Storage Company in this instance probably no one entertains the slightest doubt, and we may offer them sincere condolence upon the unfortunate issue; but that they were ill-advised to make application in such form, and that it is for the good of the community at large that such application should have been refused, we think equally evident.

With regard to the third clause of Prof. THOMPSON's indictment, in which he deals with the question of monopoly, we have always admitted that much may be said on either side. In this particular case it has been already pointed out that the decision arrived at cuts the ground from under the feet of the first of Prof. THOMPSON's protests; and hence we are entitled to argue, if we care to do so, that he is not in a position to maintain his charge of inconsistency against the Board of Trade. It is, however, more to the point to observe that the vast extension of the long-distance transmission of electrical energy has greatly altered the aspect of the problem within the last few years, and upon the whole it seems to us that the conditions of a fair field and no favour are best secured all round by the arrangement now sanctioned. We confess, however, that we were a little surprised to learn from Sir MICHAEL HICKS-BEACH in the House of Commons that any other view would have been contrary to "the clauses" of the Act of 1883. We venture to think that the President of the Board of Trade would have been considerably puzzled had he been asked to quote the clause to which he referred.

THE POSTMASTER-GENERAL AND THE TELEPHONE COMPANIES.

In the letter which the POSTMASTER-GENERAL found it necessary to address to the Telephone Companies on the very day upon which the amalgamation scheme received the sanction of their shareholders, he states that "whether such a course (namely, the amalgamation scheme) can be legally adopted under the terms of the Licenses granted by the Post Office is a question on which the POSTMASTER-GENERAL does not at present offer an opinion." We venture, with due deference, to submit that it is high time that the exact legal position of the Telephone Companies in this matter was definitely established. It seems to us equally detrimental to the public interest and to the dignity of the POSTMASTER-GENERAL himself that this important point should remain in such obscurity and doubt. It is, of course, possible that Mr. RAIKES has already satisfied himself as to the exact limit of the powers which have been conceded to the Companies, but that he is uncertain as to how far public opinion is likely to support the department in any positively hostile action which might be taken. This is perhaps the more probable alternative, especially

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in view of the fact that in reply to a question put to him in the House of Commons the same evening Mr. RAIKES remarked that he was not at all sorry that the question had been asked, because "he thought it might serve to attract attention to a matter upon which an expression of public opinion might assist the department in protecting the public interest." From the point of view of public polity the whole matter may be summed up in the inquiry: What is the public interest? Is it to the public interest to allow long-distance telephony to compete with the Postal Telegraph service on fairly level terms, or should advantage be taken of the decision of 1880, by which telephony was declared to be a department of Telegraphy, and hence to come within the monopoly of the Postmaster-General?

It is not our present intention to offer a dogmatic opinion upon the points under discussion; we would prefer for the present to echo the wish of the POSTMASTER-GENERAL that public opinion should be attracted to the question. There can be little doubt that in certain more thickly populated districts of the country inter-urban telephony has already obtained so firm a hold that public opinion would vehemently oppose its extinction, or even any serious curtailment of the facilities at present afforded for its development. On the other hand, it will readily be conceded that the question of forming a telephonic network throughout the length and breadth of the country stands upon a very different footing. From the technical and commercial point of view we think it in the highest degree problematical whether any such system could possibly be made to pay its way; that, however, is at present a question for the Companies; and if they think they see their way to its successful solution, the public will have to consider whether or not it should support the POSTMASTER-GENERAL if he decide to prohibit the experiment.

One other point must not be overlooked. By the conversion of their shares at market value the Companies are effecting an apparent increase in the amount of capital invested in their undertakings. It is both natural and right that the POSTMASTER-GENERAL, in view of the early expiry of the patents and the possibility of a departmental purchase, should inquire narrowly into the effect which such a proceeding may be expected to have. His letter may probably be taken as a warning that in the case of any compulsory transfer the present transaction may to this extent be disregarded.

THE AMALGAMATION OF THE TELEPHONE COMPANIES.

In connection with the amalgamation of the United, National, and Lancashire Telephone Companies the Secretary to the Post Office has addressed the following letter to the Secretary of the United Telephone Company:—

"General Post Office, June 4, 1889.

"SIR: The Postmaster-General has had his attention called to the notice issued by the United Telephone Company to its shareholders on the 24th ultimo, and to the course which the Telephone Companies propose to pursue with the view to an amalgamation.

"Whether such course can be legally adopted under the terms of the Licenses granted by the Post Office is a question on which the Postmaster-General does not at present offer an opinion; but he desires me to acquaint you, for the information of the directors and shareholders of the United Telephone Company, that the amalgamation of the companies was not contemplated when the Licenses were issued, and that any assurance, outside the Licenses, which the companies may conceive themselves to have received from the then Postmaster-General cannot be regarded as applicable to the state of things likely to result from the proposed amalgamation.—Yours, &c., (Signed) "S. ARTHUR BLACKWOOD."

On Tuesday evening, in the House of Commons, Mr. R. Chamberlain asked the Postmaster-General if his attention had been called to the tactics by which the financial group now commanding the telephone system of the kingdom had met his refusal to grant a License to the amalgamated company originally projected; whether his attention had been directed to the amount of capital to be created under the new scheme, and to the high charges to the public that would have to be maintained in consequence, and to the proportionately enhanced price that would be demanded should the nation ever decide to purchase; and whether, under these circumstances, he would at once avail himself of the right reserved under the agreement with the Telephone Companies, and "establish, extend, maintain, and work" a telephone system such as would gradually bring the advantages of this invention within reach of the masses of the people? Mr. Raikes said he was aware of the proceedings of the Telephone Companies. The whole question of the telephonic services of the country was engaging his serious attention. He was not at all sorry the question had been asked, because he thought it might serve to direct public notice to a matter upon which expressions of public opinion might assist the department in protecting the public interest.

ALTERNATE-CURRENT WORKING.*

BY W. M. MORDEY.

(Concluded from page 98.)

SAFETY AND SAFEGUARDS.

I take this opportunity of bringing up this question, not because I have anything new to say with regard to it, but in order, if possible, to bring it a little nearer to a rational settlement.

It will be acknowledged that the first duty of an "undertaker" using high tension is to provide for the complete and absolute safety of the consumers. If there are no means of doing this, then the system is fundamentally bad, and must sooner or later be abandoned.

There are several ways of protecting the house mains more or less completely. I only need allude to three typical plans, all of which have already been discussed before this Institution.

One is the plan introduced by Mr. Kent, of entirely separating the primary and secondary conductors in a transformer by a sheet or division of earth-connected metal. This is open to adverse criticism on some points, but, on the whole, it is an effective plan.

Another arrangement is the ingenious one of Capt. Cardew, consisting of a sort of static mouse-trap, which immediately goes off when an unauthorised P.D. enters it.

The third plan is that of earthing the secondary, and it would be very instructive if those who so strongly oppose this plan would state just one real objection to it. It is a perfectly sure method, and costs nothing.

It renders it absolutely impossible for the consumer to get a dangerous shock under any possible combination of circumstances whatever.

The faults that may occur are—

(*a*) Contact between primary main or mains and earth.

(*b*) Contact between primary and secondary in a transformer.

(*c*) Contact between a person and a portion of the secondary conductor.

(*d*) Contact between that person and earth.

Now if all these contacts occur at the same time the "person" will get a shock.

But if the secondary is earthed no shock can be obtained, except, perhaps, a slight one due to the secondary P.D.

This simple plan has been approved by almost everybody, but it is received with opposition on the part of some of the fire insurance offices and others.

It is difficult to ascertain where the supposed danger is. If the secondary is earthed, the effect of a contact between primary and secondary, when the former is accidentally leaky, is at once to blow out the primary safety fuse of the transformer, and so cut out the offending house. This is the simplest and the best course to take, and prevents the continuance on the circuit of transformers that contain faults.

The Brush Corporation has adopted this plan with perfect success on a large installation abroad, and intends adhering to it where local circumstances permit.

It is to be remarked that it is not open to the objection that has been stated against earthing of one of the primary conductors, viz., that the telephones may be affected, for it is not permanent. The moment a contact occurs that could lead to a disturbance of the telephones the fuse prevents that disturbance being continued.

While effectually removing life risks this precaution does not increase fire risks; in fact, it tends to greater safety, as it is some sort of check on the character of the house-wiring work, and so reduces chances of faults such as short-circuiting of the secondary.

The rupture of a primary safety fuse is not a serious matter, and

* Paper read before the Institution of Electrical Engineers on Thursday evening, May 23, 1889.

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in any case it is only what takes place under ordinary circumstances when any fault occurs that results in an excess of current.

As to static effects, I think it will be found that there will always be enough general leakage to prevent such effects being a cause of difficulty, even if the secondary circuits are not earthed.

Hysteresis and Eddy Currents.

Some explanation is necessary by way of preface to this section of the Paper. The experiments described were made with a direct-current dynamo, and on that account they only touch the fringe of this division of the subject. As I had no suitable alternator I was unable to pursue the question as far as I wished to do, but I hope I need make no apology for bringing forward such results as I have been able to arrive at.

As far as I am aware, no simple or practical method is known by which the power absorbed in eddy currents can be determined and separated from that due to hysteresis in the armatures of dynamos. This is a point of some importance, both as regards alternators and direct-current machines, for many reasons, one of the principal being that in the absence of exact knowledge on these matters it is difficult or impossible to determine to what extent the lamination of the iron cores should be carried. There are wide differences in the practice of the various designers and makers of dynamos in the thickness of the iron used.

Lamination may be carried to such a degree of fineness for the purpose of reducing eddy currents as to add very materially to the cost of production, the iron increasing rapidly in price as the thickness is reduced; and it may be that the point is sometimes passed beyond which no gain in efficiency is obtained. This is a question we wish to be enabled to settle.

Until Prof. Ewing* and Dr. J. Hopkinson† read their Royal Society Papers on the subject, very little was known of the heating effect of changes of magnetism. Prof. Ewing opens the part of his Paper dealing with this matter in the following terms (p. 552, *Phil. Trans.*):—

"The energy expended in a cyclic process of magnetisation can take no other form than that of heat diffused throughout the substance of the metal. Experiments have been made by Joule and others to determine by direct observation the heating effect of magnetisation in iron.‡

"In most direct measurements of this quantity no distinction is made between the heating effect due to the induction of electric currents and that due to changes of magnetisation *per se*; and so excellent an authority as Prof. Rowland, writing in 1881, has expressed himself as doubtful whether changes of magnetisation, considered apart from the currents they induce, give rise to any development of heat at all."

Further on, Prof. Ewing, referring to the dissipation of energy by hysteresis, which he had determined by laboratory experiments, says (*Phil. Trans.*, pp. 553, 554):—

"These developments of heat are so small as to make it apparent that the very considerable thermal effects which reversals of magnetism cause in the revolving cores of some dynamo-electric machines must be due almost wholly to the internal induction of currents, so far as they are not due directly to the current circulating in the coils of the armature.

"The experiments have a practical value in showing that cores which are so thoroughly laminated as to render the induction of currents within them unimportant do not involve any serious loss of energy, and that the efficiency of a machine with a soft iron core or cores whose magnetism is periodically reversed need not, on that account, be materially less than that of a machine which has no such cores. The absence of iron from the armature has been claimed, on the score of efficiency, as an important advantage possessed by some types of machine, but unless the claim has some other basis it appears to me to be illusory. Magnetic reversal does involve some loss of energy, but if the cores are properly laminated it is so small as to be practically insignificant."

I quote these passages as showing the position of the question. Prof. Ewing and Dr. Hopkinson give laboratory determinations of the magnetic loss in iron with various inductions and under various condition. It is, however, left somewhat in doubt as to whether the loss in dynamo armatures will be the same as in the laboratory experiments, the conditions being very different in the two cases.

On this point Prof. Ewing shows that hysteresis is much less when the iron is in a state of mechanical vibration than when it is in a state of rest, and states that in a dynamo the loss will be less than the experiments on still metal might lead us to expect.

Another way in which the dynamo conditions may cause some difference is the possible variations of the magnetic density that may exist in the core. Such variation may be considerable in armatures of large size.

Dr. Hopkinson (*Phil. Trans.*, p. 467) takes the magnetic loss in armatures as being the same as in the small pieces of iron tested by his method, and gives an example calculated for an armature core "finely divided, to avoid local electric currents."

It is to be noted, then, that both these authorities regarded eddy currents as unimportant in laminated armatures; but in the later Paper on "Dynamo-electric Machinery"* Drs. J. and E. Hopkinson published their famous investigation into the efficiency of dynamos, and gave very full particulars, from a study of which it is possible to ascertain the loss in eddies, on the assumption that the method of calculating the magnetic loss is correct when applied to armatures—a point which Dr. Hopkinson was not able to decide positively; but by assuming that it is applicable, then, by subtracting the calculated hysteresis loss from the ascertained total power unaccounted for, the eddy current loss is obtained, and as this process gives the hysteresis as accounting for only about 40 per cent. of the total loss in the armature core, it shows that the eddies could not by any means be considered unimportant, although the lamination was carried out to the extent of making the iron about 0·02 inch thick.

I now wish to describe a method by which the amount of loss due to each of the two causes may be ascertained experimentally in the workshop on a practical scale. It is a very simple one, although not, perhaps, capable in all cases of the highest scientific accuracy.

(*a.*) First run the dynamo on open circuit at various speeds (two readings will suffice), with the fields unexcited, or, better still, entirely absent, and measure the power absorbed in friction. Plot this value to any suitable scale, as O M in Fig. 3, the ordinates representing horse-power, while the abscissæ represent revolutions per minute.

In the figure the mechanical friction, being a quantity with which in this investigation we are not directly concerned, is plotted below the base line O M', in order that the other losses may be more clearly seen.

(*b.*) Next run again on open armature circuit with the brushes removed and the field normally excited, and measure the power absorbed. This will be the total power dissipated in friction, hysteresis, and eddy currents, if any, and must be plotted as O N. Then the ordinates lying between O N and O M' represent the sum of the losses due to hysteresis and eddy currents, and somewhere between O M' and O N must lie a line O P, separating the hysteresis from the eddy-currents.

We desire to find the position of this line. The difference between the rate of increase of the electric and magnetic losses enables us to separate them from each other. It may be taken that, with any given constant excitation, the loss from hysteresis is directly proportional to speed, within certain limits to be hereafter stated. The resistance (that of the iron) being constant, the eddy currents must vary as the first power of the speed, and the loss therefrom as the square of the speed.†

It will now be seen that it is easy to separate the values which are directly proportional from those which are proportional to the square of the speed.

Prof. S. P. Thompson, to whom I submitted this method, has kindly given me the following concise formulæ for finding the quantities:—

P and P_1 are respectively the combined magnetic and electric losses at the speeds S and S_1.

k = magnetic loss;
k_1 = electric loss.

$$k = \frac{P_1 S^2 - P S_1^2}{S^2 S_1 - S S_1^2};$$

$$k_1 = \frac{P S_1 - P_1 S}{S^2 S_1 - S S_1^2}.$$

Then, at any speed n,

Hysteresis $= k n$;
Eddies $= k_1 n^2$.

If armature cores are run in an excited field before winding, it can be determined to what extent their lamination is satisfactory and whether the iron is of good quality; and then, after winding the armature conductors, another test shows what the additional increase in the loss is, and separates the effects of eddy currents in the core from those in the conductor, and the hysteresis from both. The method may also be useful to investigate the losses in the cores of armatures of different types or differently built up, as, for instance, with iron wire or iron sheets.

This method has a useful application in rendering it possible to separate not only the magnetic loss from the electric loss in the iron, but to determine the waste by eddies in the copper winding of armatures.

* Prof. Ewing, "Experimental Researches in Magnetism," *Phil. Trans.*, Jan., 1885.

† Dr. J. Hopkinson, "Magnetisation of Iron," *Phil. Trans.*, April, 1885.

‡ Joule, *Phil. Mag.*, Vol. XXIII., 1843; Grove, *Phil. Mag.*, Vol. XXXV., 1849; Villari, *Nuovo Cimento*, 1870; Cazin, *Ann. de Chem. et de Phys.*, 1875; Trowbridge, *Proc. Amer. Acad. of Arts and Science*, 1879.

* *Phil. Trans.*, Part 1, 1886, p. 331.

† Prof. Thompson's "Dynamo-Electric Machinery." 3rd Edition, p. 102.

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It is usually entirely a matter of opinion as to how much of the power absorbed in running an armature on open circuit is due to any of the various causes referred to; and now that it is customary to wind armatures with heavy conductors, it becomes very desirable to be able to find in any particular case what proportion of the loss is in the copper and what in the iron.

In Fig. 3 are shown some results obtained with a four-pole (direct-current) Victoria dynamo run at various speeds up to 1,200 revolutions per minute, with constant excitation. Power readings were taken by means of a White's transmission dynamometer, constructed by the Brush Corporation for the purpose of testing dynamos; and the horse-power absorbed in mechanical friction in dynamo, belt, and dynamometer was subtracted from the power spent electrically and magnetically.

To reduce errors in the dynamometer readings the dynamo was fitted with two pulleys, one twice the diameter of the other. This allowed of the dynamometer being run at the same speed, while two different speeds of the dynamo were obtained by changing the belt from one pulley to the other. Readings were taken at four speeds, viz., 450, 600, 900, and 1,200 revolutions per minute, corresponding to 15, 20, 30, and 40 ∿ per second. The position of O P was readily found by "trial and error," this being a shorter process for a concrete instance than the application of the general

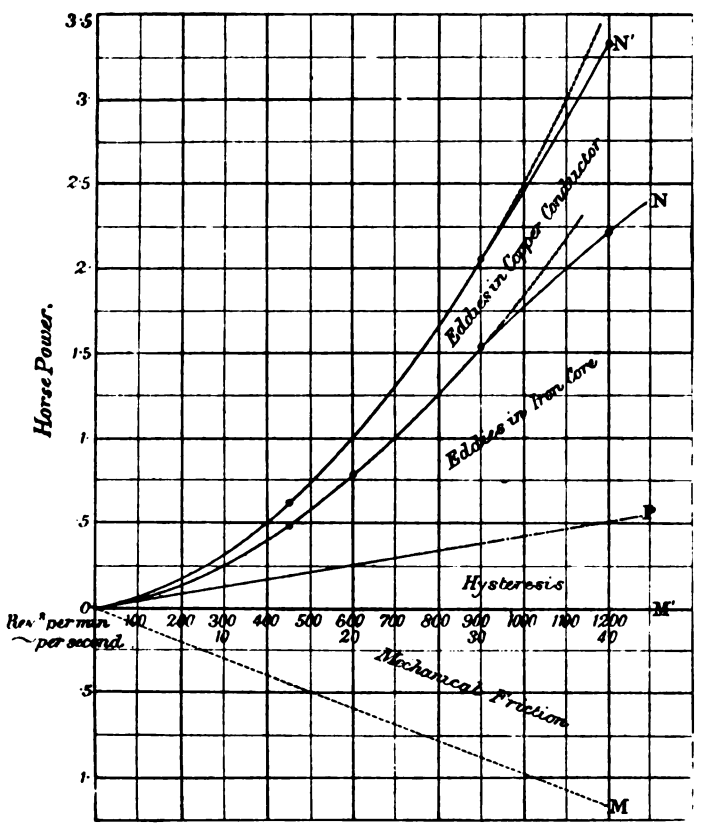

Fig. 3.—Determination of Losses in Dynamo Armature.

formulæ. The assumption on which this method of testing is based was found to be correct up to 900 revolutions. The reading at the higher speed of 1,200 revolutions, or 40 ∿, shows that disturbing influences began to affect the results by reducing the rate of increase of the losses. The continuation of the curve O N in a full line shows the actual loss, while the continuation in a dotted line, which is a parabola on O P as an abscissa, shows what the loss would be if the rate of increase holding for low speeds were maintained.

This shows that this method is perfectly applicable to ordinary direct-current machines—for instance, to two-pole dynamos up to 1,800 revolutions per minute, or 30 ∿ per second—but that it is less useful for alternators.

The disturbing causes are probably rather complicated. They may be due partly to self-induction in the circuits of the eddy currents, to lower magnetisation (although this effect, if present, is very slight, as was shown by the E.M.F. being almost perfectly proportional to speed), and to vibration. "Viscous hysteresis," if it exists, will raise the magnetic loss. There may be such an effect, in spite of the lowering of the curve, but it cannot be recognised, on account of the unknown variation of the eddies, at the higher speed. Iron-cored alternators working at high periodicities may be tested in the following way, which will give some approach to correct results:—Let the test be taken at a low speed (not more than 30 ∿. This will give the hysteresis per period and the eddies at that speed. Then, if at any higher speed the E.M.F. is proportional to speed, it may be assumed that the magnetic induction is the same as before, and the hysteresis per period will at any rate not be less than at the lower speed. It may be more. The difference between the calculated hysteresis, O P, and the ascertained total loss, O N, will be the eddies; or, if viscous hysteresis is a fact, it will be extra loss due to viscosity plus that due to eddies.

Heating of the armature core, and consequent increase of the resistance of the iron, is not responsible for the bending down of the curve O N in Fig. 3 (although it would have that effect under ordinary circumstances), as the experiments did not occupy sufficient time to allow of any sensible rise of temperature. The effect is probably very complex and obscure, but it is one that well deserves study on account of its present industrial importance.

It should be stated that the dissipation of energy (which has been spoken of as being in the armature) may be partly in the field magnets. This was, however, not the case in the experiments referred to. The conditions necessary for the prevention or reduction of eddies in the iron of field magnets are now pretty generally understood,* but it should be observed that it is not by any means as easy to check such waste in alternators as in ordinary dynamos. It is both better and easier to prevent than to cure them.

If a good transmission dynamometer is not available, results almost or perhaps quite as good may be obtained by running the machine at various speeds by means of an electric motor, and measuring the power required by the motor—first with the fields of the machine unexcited, to get the mechanical friction, and then with the fields excited, to get the total loss. The motor should then be run alone, to find what is absorbed in driving it at various speeds. The increase in watts over these last values, with the internal losses in the motor conductors calculated out and subtracted, will give, with a very fair degree of accuracy, the energy dissipated in the machine under test.

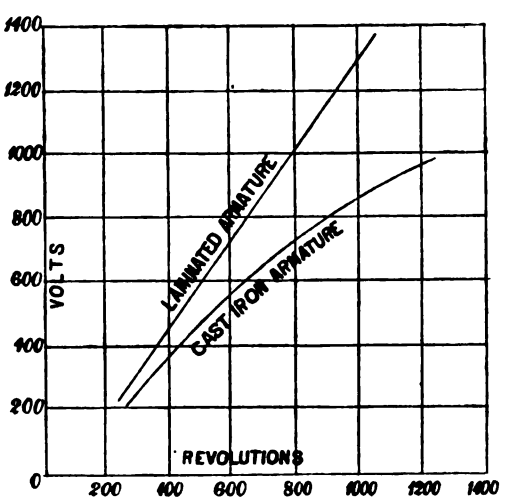

Fig. 4.

The upper curve, O N', was plotted from readings taken after the armature was wound, and the difference in the ordinates between O N and O N' shows the eddy current loss in the copper conductor at various speeds. This loss, like that of the eddy currents in the iron, rises as the square of the speed up to 900 revolutions, or 30 ∿, above which it rises rather less quickly. The full line O N shows the actual loss, the dotted line above it showing what it would be if the rate of increase were maintained. The difference is no doubt due to self-induction.

That the effect of self-induction is not noticeable unless the eddy currents are considerable is in accordance with experiments that I published some years ago in connection with the Brush dynamo.† The results then obtained are shown in Fig. 4. The straight line connects speed and the potential difference at the terminals with the laminated armature; the lower and slightly curved line shows the potential difference with the old form of cast-iron armature, which had only coarse divisions, scarcely meriting the term "lamination." The curve shows that the E.M.F. rose less quickly than the speed on account of the serious generation of eddy-currents.

* See numerous practical notes on this subject scattered through Prof. Thompson's "Dynamo-Electric Machinery."

† *The Electrician*, October 2nd, 1885.

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In the laminated armature, although, of course, there were still eddies, their effect was not sufficient to cause any bending down of the E.M.F. line at any practicable speed of driving.

Coming now to an examination of the results obtained in the experiments, and shown in Fig. 3, we see that the hysteresis loss in this particular dynamo—which I should mention is capable of working continuously with a normal load of 18,000 watts—was 0·195 horse-power at 450 revolutions, and 0·39 horse-power at 900 revolutions, the latter corresponding to 30 ∿ per second.

The magnetisation* was about 12,300 C.-G.-S. lines—not by any means a high density. The armature had a ring core, nearly square in cross-section, of 12 square inch area, and contained 615 cubic inch, or 10,086 cubic centimetres of iron strip 0·012in. thick (No. 30 B.W.G.) separated by paper. This is a degree of lamination beyond which it is inconvenient to go. The peripheral portion was wound with this iron in parallel bands ½in. wide, in order to reduce eddies caused by lines entering the periphery. The main inner portion of the core was of wider strip.

We find from the figures that the loss in hysteresis at 900 revolutions was as follows :—

0·39 horse-power = 291 watts = 0·473 watts per cubic inch, or 0·029 watts per cubic centimetre. As the periodicity was 30, the 9,613 ergs, or of energy per complete period per cubic centimetre was dissipation 0·001 watts nearly.

It is interesting to compare this result, obtained in what may seem a rather crude manner, with the values given in the Papers referred to. Prof. Ewing says (*Phil. Trans.*, p. 553) ". . . the double reversal of a strong condition of magnetism in soft iron involves the expenditure of about 10,000 ergs per cubic centimetre." He gives the energy as 9,300 ergs, with a magnetisation of 13,190 in very soft annealed iron. Dr. Hopkinson gives 13,356 ergs, with a magnetisation of 18,250.

Much of course depends upon the quality and hardness of the iron, but my results come out very close to those of Prof. Ewing and Dr. Hopkinson. This may be taken as proving the method capable of considerable accuracy. The eddies in the iron, it will be seen, are by no means to be neglected, even with the very fine subdivision that was used.

The eddies in the conductor are rather greater than usual, as the armature, being intended for a very low speed, had a larger amount of copper on it than usual.

The bearing of these curves on iron-cored alternators and on open circuit-working generally is obvious. With a magnetisation of 12,000, the loss in hysteresis alone, at 100 ∿, would be over 1·5 watts per cubic inch of iron core, and the eddies would amount to a good deal more. I will only add that the eddies, both in the iron and in the copper, are greatest when no external work is being done, as was the case in my experiments. They are reduced by the effects of self-induction when the circuit is closed. A difference exists in this respect between generators and motors, a difference in favour of generators.†

I will not further extend this Paper by dealing at greater length with this part of the subject.

Resumed discussion of Mr. Mordey's Paper on "Alternate-Current Working," Thursday, May 30th, 1889 :—

DISCUSSION (AUTHORISED ABSTRACT).

Before the discussion on Mr. Mordey's Paper on "Alternate-Current Working" was proceeded with, the author exhibited and described an automatic current regulator, arranged to work within half per cent. without "hunting," and also explained a model and drawings of his single-coil alternator. During the week he had received letters, amongst others from Lord Rayleigh, Prof. Ewing, and Mr. Zipernowsky, bearing on his Paper, from which he now read extracts. Lord Rayleigh pointed out that in the *Phil. Mag.* for 1886 he had worked out the virtual resistances of conductors. He also thought the term *frequency* better than *periodicity*. Prof. Ewing referred to the work lost in hysteresis, and Mr. Zipernowsky promised to forward his criticisms later on.

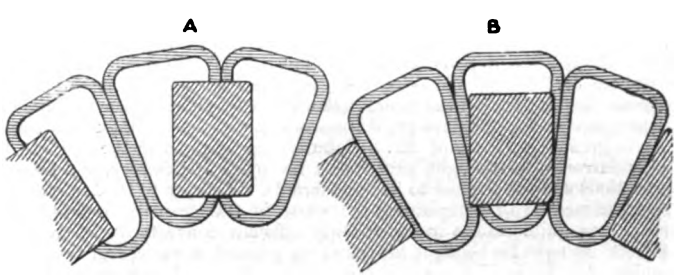
Prof. FORBES read some notes by Dr. Hopkinson, who states that to obtain direct control in parallel working neither large self-induction nor small self-induction are essential, but the best control is exerted when $\frac{2\pi\gamma}{T} = r + R$, where γ = coefficient of self-induction, T = period, and $r + R$ is the resistance of armature and leads. If the resistance of the leads or feeders be considerable, parallel working is more difficult. In his Paper of November 13, 1884, the case of putting generators giving different E.M.F.'s in parallel was shown to be feasible, and from the equations of § 3 the work done by the leading machine becomes zero when $\frac{2\pi\tau}{T} = \frac{\pi}{2}$, where 2τ is the difference in time phase. Dr. Hopkinson also says that all the phenomena observed by Mr. Mordey could be predicted from his 1884 theory.

Prof. THOMPSON read a communication from Prof. Adams, in which attention is directed to the South Foreland trials of 1884, described in his Paper read on November 13 of that year, in which many of the experiments mentioned in Mr. Mordey's Paper were performed satisfactorily. He regarded Mr. Mordey's statement on page 4, that alternators with small self-induction and resistance "will best run parallel because they will be the best synchronising motors," as equivalent to saying that "tuning forks synchronise when in unison." Reference was made to the beats shown by the synchronising lamp when one machine was running at half the speed of the other, and from acoustical analogues Prof. Adams thinks alternators will run as motors at speeds corresponding to fractions or multiples of that of the generator. He attributes the active cause of synchronising to self-induction, and considers that the groaning heard when the machines were switched parallel to confirm this view.

Major CARDEW, referring to the frequency at which the temperature of lamp filaments begin to follow the current, said that in experiments on signal flashes about ten changes per second could be clearly seen. The section on Safety and Safeguards seems to him to imply that the faults *a*, *b*, *c*, *d* must occur simultaneously if a person is to receive a shock, but the speaker thought *a* and *b* may exist unknown to a person who accidentally or otherwise touches the secondary whilst making contact with earth. Earthing the secondary, though safe as regards shocks, might considerably increase fire risks.

Dr. FLEMING, speaking from information recently obtained in Milan, said there was no difference between the average life of lamps worked by direct or alternating currents. As a possible explanation of the observations on the periodicity which gives maximum efficiency, he suggested that for rapid changes the viscous hysteresis was most important, whilst for slow ones the eddy currents penetrated further into the metal, thereby wasting more energy. He thought the Institution greatly indebted to Mr. Mordey for demonstrating successful parallel working without much self-induction or resistance, and pointed out that to work alternators parallel satisfactorily not only must the machines come into step, but they must do so promptly and considerable stability must exist. These conditions may be satisfied by suitably shaping the field poles and armature coils, for on these the shape of the E.M.F. curve depends.

Mr. KAPP complimented the author on his valuable Paper, not as a formality but because it was one of the best ever brought before the Society. In his remarks on the Paper he thought it was not at all clear how the E.M.F. of a machine excited to give 1,000 volts rises to 1,500 when placed in parallel with one giving 2,000 volts, but according to his idea this was probably due to the armature current demagnetising the field of the generator and magnetising those of the motor. He questioned whether the self-induction of the armature was insignificant, for when the field poles were central with the coils they would act as cores for the coils which would therefore have considerable self-induction. This will vary with the relative positions of the magnet and armature, and tend to pull the machines into step.



Mr. SWINBURNE suggested as a satisfactory test of parallel working that the machines should be capable of being kept on full load without undue heating of the armatures. Referring to the word "synchronising," he thought its use in the Paper rather ambiguous, for in some cases it related to speed and in others to phase. As regards the efficiency of transformers working at different frequencies, he thought the comparison ought to be made on different transformers, each designed for the frequency under which it was tested. Under these conditions, and with 50-light transformers, increasing the frequency from 42 to 83 raises the efficiency from 92 to 93 per cent. when worked at full load all day, and from 60 to 62 per cent. when working at full load for two hours out of the 24. From some recent calculations he found the loss from eddy currents in direct-current armatures to be unimportant when thin plates were used.

Prof. S. P. THOMPSON, speaking of arc lamps, announced that he had recently localised the back E.M.F. in direct-current lamps, and found a sudden change in potential of 39 volts at the crater. He questioned Mr. Kapp's statement about the field magnets increasing the self-induction of the armature, for the time was too small (about $\frac{1}{200}$ second) to allow such masses of iron to change their magnetism in obedience to the armature current. Prof. Thompson also gave a graphical construction for showing the distribution of work between two machines of different voltage when switched in parallel.

Prof. AYRTON, having obtained measurements of the self-induction of Mordey armatures by the secohmmeter, was in a position to say that neither Mr. Kapp nor Dr. Thompson were quite correct, for the coefficient was 0·038 in position A (see Figure) and 0·036 in position B ; and both decreased about 14 per cent. when the magnets were fully excited. The frequency of the testing current was about 100 in all the tests. From experiments recently made at the Central Institution on the efficiency of the Mordey transformer, with frequencies varying from 53 to 240, he said there is no evidence of greater efficiency for medium frequency ; on the contrary, the efficiency increases with the frequency, particularly for small loads, and is nearly the same for all frequencies at the maximum working load.

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* The use of the word "induction" in so many senses is apt to cause confusion. "Magnetisation" would perhaps be better than "induction," "magnetic induction," "density," "magnetic density," &c.

† *Phil. Mag.*, January, 1886, p. 26. "The Dynamo as a Generator and as a Motor."

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Exciting current.	Position of armature.	p	q	Secohm standard.	Secohms.
0	A.	1,000	1,500	·0255	·038
0	B.	1,000	1,500	·0218	·033
0	B.	1,000	1,500	·0230	
40	A.	1,000	1,000	·0365	·036
40	A.	1,000	1,000	·0360	
40	B.	1,000	1,000	·0295	·030

Prof. FORBES thought the fact of the engines driving the alternators when the experiments were made being ungoverned should be clearly stated in the Paper, for this helped considerably to explain the phenomena. He also believed Mr. Mordey was perpetuating an error if he assumed that only two methods of distribution were possible, either separate large machines or small ones in parallel, but it was quite common in America to divide the mains and connect them to separate machines when necessary, and the circuits are so arranged that two or more may be switched on one machine during the hours of minimum demand.

The PRESIDENT (Sir W. Thomson) suggested the expression "cophasedly synchronised" as meaning that the machines were in step both as regards phase and speed. To explain the result of coupling two alternators at 1,000 and 2,000 volts respectively, he considered the current resolved into two components differing by a quarter of a period and having their respective maxima at the positions A and B in the above figure. The latter component would tend to magnetise the motor fields and to demagnetise those of the generator, and in this way produce the observed phenomena. Referring to the single-coil alternator, he thought it a beautifully simple and ingenious machine, and though some loss would arise from magnetic friction, this need not be great.

Mr. RAWORTH, who during the week had made experiments on the E.M.F. curves of alternators and transformers, exhibited a diagram showing the arrangement adopted. The results, though incomplete, were, he said, astonishing, and he thought the question of lag would be settled in a manner not in accordance with theory.

Mr. MORDEY, in reply, said Dr. Hopkinson's difficulty arising from the loss in leads was not a serious one, for the high potential used in transformer systems rendered any considerable loss unnecessary. Referring to Prof. Adams' criticisms, he said he had laid no claim to the invention of parallel working, but had shown it to be perfectly practicable at a time when, in spite of the success obtained by Prof. Adams (to which he had drawn attention in his Paper), considerable doubt existed as to its commercial possibility. He considered Dr. Fleming's explanation of the minimum generation of heat for mean periodicity a very probable one, and mentioned that although the heating at periodicity 125 was more than that at 100, yet the current passing through the transformer was less in the first case. As regards Mr. Kapp's difficulty, Mr. Mordey admitted that a change of 500 volts did occur, and although he had not attempted to explain the matter, yet the straight characteristic given by the machine as a generator was a sufficient proof that as a motor the self-induction could not be great. Speaking of Mr. Swinburn's calculations on the loss due to eddy currents, he thought experiment far more satisfactory, and his observations showed the loss to be considerable. In reply to Prof. Ayrton he said the method of determining the waste in transformers by direct currents was quite safe to use with fairly efficient converters. From Prof. Forbes' remarks he thought his views on parallel working had been misunderstood, for he did not recommend it under all circumstances, but in cases where all the prime motors and alternators would work without requiring a large margin it is a great convenience to arrange the leads and mains so that they may be connected in parallel.

Hookham's Electricity Meter.

The inventor exhibited and described the working of his meter, details of which have appeared in the technical papers [*Electrician*, February 1, 1889, p. 369].

In the discussion which followed, the PRESIDENT asked what precautions were necessary to make the mercury contacts with the commutator satisfactory, and was informed that simple amalgamated line contacts were found suitable, and no appreciable resistance existed even after working many months.

Mr. CROMPTON said it was very difficult to make such meter register accurately for small currents, and in Mr. Hookham's instrument the error was very favourable to the supply company. In this he was corrected by the President and Mr. Hookham, the former of whom also pointed out that any error of this kind should be favourable to the consumer, for a few lamps more or less during the day load would make no appreciable difference to the coal bill of the producer.

Mr. S. JOYCE concurred with Mr. Hookham as to the permanency of good magnets, for he had re-tested permanent magnet instruments after being in use six years, and had found them unaltered. He also inquired whether the meter could be tampered with by the consumer, and the inventor was understood to say that as the cover was sealed on this was impossible.

Mr. HOOKHAM referred to a 100-ampere meter, in which the motor was shunted by German silver, and the temperature effects tend to compensate each other. The process of making the permanent magnets was described, from which it appears that they are first magnetised, and then weakened about 10 per cent., to give them a tendency to strengthen. The great secret of obtaining constancy was said to be making the magnetic circuit as nearly closed as possible, and instruments constructed on the plan described showed no appreciable variation after 18 months' work.

ELECTRIC CONSTRUCTION CORPORATION (LIMITED).

A prospectus was issued early this week, announcing that the list of applications for shares in this Corporation would open on Tuesday, the 4th of June, and close on or before Thursday, the 6th. The prospectus announces the amalgamation and purchase of the undertakings and patents of Messrs. Elwell-Parker (Limited), of Wolverhampton; the Electrical Power Storage Company (Limited); the Railway Electrical Contractors (Limited); the Julien Patents for Electric Traction; and the Sprague Patents for Electric Traction and Transmission of Power. The capital of the Corporation is £500,000, in 50,000 shares of £10 each, of which Nos. 1 to 100 inclusive are founders' shares. The present issue is 45,000 shares of £10 each.

The Directors are:—

Sir DANIEL COOPER, Bart., G.C.M.G., Chairman Electrical Power Storage Company (Limited).

JOHN IRVING COURTENAY, Esq., Managing Director Electrical Power Storage Company (Limited).

GEORGE DIBLEY, Esq., Director Andrew Handyside and Co. (Limited).

Sir ROBERT FOWLER, Bart., M.P., Director Metropolitan Electric Supply Company (Limited).

Sir DOUGLAS FOX, J.P., Member of Council of the Institution of Civil Engineers.

HENRY P. HOLT, Esq. (Crossley Bros., Limited, Manchester), Director Elwell-Parker (Limited).

Sir HENRY C. MANCE, C.I.E., Director West African Telegraph Company, late Engineer and Electrician to the Indian Government, Persian Gulf.

JOSEPH MOSELEY, Esq. (Messrs. David Moseley and Sons, Manchester), Chairman Elwell-Parker (Limited).

JAMES PENDER, Esq., J.P., Thornby Hall, Rugby, Director Eastern and South African Telegraph Company.

JOHN B. VERITY, Esq. (Messrs. Verity and Sons, Covent Garden).

H. GRANVILLE WRIGHT, Esq., Ingram House, Fenchurch-street.

The last two gentlemen are Directors of the Metropolitan Electric Supply Company, Limited.

The Managing Director is JOSEPH SMITH, Esq.; the Works Director is THOMAS PARKER, Esq.; the Consulting Engineers are Sir WILLIAM THOMSON, F.R.S., LL.D., D.C.L.; JOSEPH KINCAID, Esq., M.Inst.C.E., and SAMUEL SPRUCE, Esq., M.E., F.G.S.; the Engineer is J. E. H. GORDON, Esq., M.I.E.E., and the Secretary (*pro tem.*) is Mr. A. W. BARR.

The prospectus states that the Corporation is established to supply the enormous and increasing demand for all kinds of electric machinery which has arisen in consequence of the remarkable development of electricity both as an illuminating and a motive power.

In addition to this, the Corporation proposes to supply machinery for electric power for traction and other purposes to which electricity has been applied with so much commercial success in the United States and elsewhere.

The Corporation acquires—(*a*) The works and business of Elwell-Parker (Limited), of Wolverhampton. The progress of this business since its establishment has been one of marked success. More than 500 men and boys are at present employed, and the orders obtained since the beginning of the present year already exceed those received during the whole of the year 1888. The business is taken over as from the 30th September last, from which date all profits accrue to the Corporation.

(*b*) The works and business of the Electrical Power Storage Company (Limited), including the factory at Millwall, and the whole of the English and foreign patent rights and the royalties and profits receivable from licensees in this country and from Continental and American Companies in respect of secondary batteries manufactured abroad under the Electrical Power Storage patents.

(*c*) The patents and business of the Railway Electrical Contractors (Limited), with its present working contracts for railway train lighting.

(*d*) The Julien Patents for the United Kingdom for electric traction, and the Sprague Patents for the United Kingdom for electric traction and transmission of power.

The scheme of amalgamation has been submitted to Mr. W. H. Preece, F.R.S., and Mr. C. E. Spagnoletti, M.Inst.C.E., who report favourably of the amalgamation, and express their opinion that with proper administration and management the returns should be eminently satisfactory.

The Directors of the Corporation consider that a minimum annual dividend of 10 per cent. may be fairly anticipated, and a portion of their annual remuneration and the whole of the profits upon the founders' shares are contingent on such dividend.

In re THE NEW TELEPHONE COMPANY.

Before Mr. Justice Stirling, in the Chancery Division, on Saturday last, a petition for winding up under supervision order was presented by the company itself. Mr. Buckley, Q.C., stated that the company in November, 1884, commenced to carry on a telephone business. The capital of the company was represented by 1,000 shares issued as fully paid-up, and £9,433 paid on other shares. The collapse of the company had been caused by an action having been commenced in March last against them by the United Telephone Company, to restrain this company from working infringements and other patents. An injunction was obtained in that action which had not been further prosecuted. Nothing further had been done by the company, which, unfortunately, had got to the end of its powers. An extraordinary general meeting was held on April 29 last, when the company passed an extraordinary resolution in favour of winding up and for the appointment of Mr. Ogle as liquidator. The debts amounted to £2,339, and assents to the supervision order being made had been signed by the majority of the creditors. His lordship made the order asked.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *May* 25, 1889.

The number of departures for Europe this month has been remarkably large, and I do not know any year in which so many electricians have sailed for Europe, or will do so before the season is over. Of course the Paris Exposition is the great special attraction, and most of the electricians going over have work to do in connection with the exhibits at Paris, or propose to make a special study of what is to be seen there. There are also a great many who will be on the *qui vive* to pick up new ideas and new apparatus for exploitation in this country, and others, again, who propose to see what can be done in placing American systems of light, power, &c., on the European market.

The owners of the celebrated Comstock Lode at Virginia City have for a long time felt that the exigencies of their operations demanded not only more power, but power at such a cost as would enable them to work their enormous quantities of low-grade ore at a profit. They have, at heavy expenditure, carried water from streams in the Sierra Nevada Mountains, 30 miles off, but the supply has never been sufficient, and the working of the mine has been frequently suspended in consequence. A perfect and remarkable solution of their difficulties, however, has just been effected. The stamp mill of the Nevada Mill and Mining Company has a water-power at the level of the mill, supplied from a reservoir at the side of the mountain, and, finding this water-power inadequate for their operations, the company compared notes with the Comstock people. The matter was referred to the Brush Electric Company, through its agents, the California Electric Light Company, of San Francisco, and the speedy result was a proposition to collect the waste water from the surface wheel at the mill, convey it in pipes to the shaft of the Chollar mine, which is close to the stamp mill, and thence down the shaft, until a sufficient head should be obtained to produce the power required. This was a bold scheme, but it was pronounced practicable, and work was begun last winter. At the 1,650-foot level of the Chollar mine a chamber 50ft. long, 25ft. wide, and 12ft. high was excavated out of the solid porphyry, in which the dynamo-electric generators were placed. From the waste surface tank two wrought iron pipes, one 10in. and one 8in. in diameter, are led to the subterranean chamber. At the bottom of the shaft these two pipes are united into a single one 14in. in diameter, from which six 6in. pipes run to the nozzles of the water-wheels provided to drive the large Brush dynamos. Of these there are six, which are mounted on a heavy cast-iron base, and are provided with an extended shaft and outer bearing. On each armature shaft, and between two bearings, a Pelton water-wheel is mounted, enclosed in a water-tight cover. The generators are each of 130 horse-power capacity, and are compound-wound for constant current. Their electrical curve is as near perfection as possible, and they require no regulator. The current is of constant strength under all conditions of load. One of the most remarkable points about this plant, however, is the head of water at the underground chamber, which is 1,650ft. Never before has such an enormous pressure been used for the purpose. The "Pelton" water-wheels, which were selected as the best adapted to the special conditions, are provided with an ingenious wedge-shaped partition, by which the stream of water is divided and sweeps out through the curved sides in such a way as to produce a reactionary effect in addition to the impact, and the water is all thrown down and out of the way of the wheel. The six wheels, which are made of phosphor bronze, are each forty inches in diameter, and weigh 220 pounds, and they drive the generators at a speed of 900 revolutions per minute. The machines are arranged in two parallel rows of three, and work with such perfect smoothness that of the 800 horse-power generated there is no evidence save the motion of the swiftly revolving armatures. Thirty-six Swan incandescent lamps, operated in multiple series from one of the generators, illuminate the chamber, and there are several of the same lamps in the incline. Each generator circuit has a Brush dead-beat ammeter, and a Brush voltmeter capable of measuring up to 3,000 volts is also provided. Any generator can be thrown on to any one of the outgoing circuits by a switchboard in the dynamo room, to which the generator circuits are led. As the circuits of copper wire ascend, one to each generator, they pass through a shower of spray, but the insulation is so excellent that no sign of a leak has yet been seen. The wires are carried above ground to the electric motor room at the Nevada Mill, the length of each circuit being a little more than a mile. The six motors in the motor room are of the regular Brush constant-current type, each of 80 horse-power capacity, and arranged in a single row parallel with the main driving shaft, to which they are belted. The surface wheel, which is also connected to this shaft, uses the water in the first instance and furnishes part of the power to drive the main shaft. The waste water is then carried down the Chollar shaft to the underground chamber, where its drives the dynamo which generates the electric current and energises the electric motors above ground, which in turn furnish additional power to the main shaft. A more complete triumph of adaptation it would be hard to find. Each motor has its own independent circuit fed from one of the generators, and its speed is regulated by the well-known Brush regulator. All or any number of the motors work perfectly in a battery together or with the water-wheel, and they run at a speed of 850 revolutions per minute. An ammeter for each motor indicates at all times the current flowing in each circuit. Some idea of the saving effected by this plant to the mine-owners may be formed from the fact that the surface wheel alone requires 312 miner's inches of water to develop power sufficient to drive 40 of the 60 stamps with which the mill is equipped. As a matter of fact, this amount of water is seldom available. Two of the electric motors, working in addition to the surface wheel, will perform the same work with but 72 miner's inches of water, thus effecting a saving of about 77 per cent. The net commercial efficiency of the plant is about 70 per cent. The waste water from the 1,650ft. level of the Chollar Mine is now, I may add, piped into the Sutro Tunnel, and it is seriously proposed to use this water a third time at a lower level for other work by duplicating the electrical machinery.

The trial trip of the Topeka (Kan) Rapid Transit Electric Railway took place on April 3rd, and the road has since proved a great success. This is the longest line which has yet been built using one system and receiving its current from one central station. The Thomson-Houston Company, which has already done such excellent work in railways, has spared no trouble to make the efficiency of this line of the highest possible order. The road is 14 miles long, and has a total length of track of 20 miles. The power station is a handsome brick building. Its length is 100ft. by 85ft. wide. One-half the building is two stories high, and at the rear is a chimney 125ft. high. The solid masonry of the foundations of the engines and dynamos rests on bed rock, and the utmost stability and firmness are thus ensured. The two engines are of the Corliss type. The smaller engine is capable of developing 300 horse-power, and its fly-wheel, which is 20ft. in diameter, weighs 26,000 pounds. The larger engine is of 600 horse-power, and its 20ft. fly-wheel weighs 20 tons. The smaller engine is situated at the end of the building, and the larger one directly opposite. Both are belted to the main shaft, which runs the entire length of the building. The engines run at 80 revolutions per minute, and there is not the slightest jar perceptible. The foundations are entirely independent, each engine resting on a concrete base, upon which are placed large blocks of stone laid in cement to a thickness of about 10ft. The steam for these engines is supplied from a battery of five boilers, which are of the best quality of steel, and are 6ft. in diameter and 16ft. long. They are located between the engines in a brick enclosure, which isolates them from the dynamo and engine room, and are so arranged that they can be run separately or in series. The feed water is taken from wells 65ft. deep. The water is first pumped into an exhaust receiver and then raised to a temperature of 212° Fahrenheit. The water enters at the top, and is received by a crescent-shaped pan, over the edges of which it runs until it reaches the centre, when it drops into a similarly shaped pan, and so on into another pan, until it passes through 16 different pans. By this arrangement the exhaust steam strikes

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the water as it drops from pan to pan 16 different times, and removes its impurities. This water is then delivered by a special pump fitted for handling hot water into a superheater which is placed above the boilers. The heater, which is 26ft. long, contains 24 pans like those already mentioned, and it is kept at a temperature of 320 degrees by a full pressure of live steam from the boiler. This high temperature naturally purifies the feed water, and its lime, iron, magnesia, and other impurities collect on the bottom of the pans. The floor of the boiler room is paved with hard brick, and a track for the coal car runs in front of the furnace doors for the transportation of coal. The electrical apparatus consists of five 80 horse-power Thomson-Houston generators for supplying the necessary current. These generators are compound-wound and connected in multiple. A large switch-board is fitted with the necessary current indicators, switches, &c. The cars, already 12 in number, are each equipped with two 10 horse-power motors. The overhead system has been used, and the rails serve for the return circuit.

The annual meeting of the American Institute of Electrical Engineers has been held in this city this week. The proceedings began Tuesday evening and terminated Wednesday evening. At the closing session on Wednesday evening Prof. H. A. Rowland, Ph.D., of Johns Hopkins University, delivered a lecture on "Modern Views in Respect to the Nature of Electric Currents," illustrated by numerous experiments. The lecture was listened to with the greatest interest and appreciation by a representative audience of 350 electricians and their friends, and a more masterly enunciation of the subject in a popular yet scholastic way has never been heard. The American Institute of Electrical Engineers has a great future before it, and that it realises its mission is abundantly evidenced by its sterling contributions to science and its energetic general management. Prof. Elihu Thomson has been elected president for 1889—a man whom we all delight to honour.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *May* 31, 1889.

During the year 1888 the Electrical Department of Messrs. Ganz and Co. carried out 108 electric light installations with 560 arc and 54,000 glow lamps, including 20 central stations and 88 isolated plants. The company has also asked permission from their shareholders to join the Augsburg Gas Company in opening a central electric light station in Innsbruck and other places; further, to join the Union Bank in promoting the International Electrical Company in Vienna, and to take 250,000fl. of shares in this company. This company has since been brought out by the Union Bank with a capital of 3,000,000fl., and it has the right of using all Messrs. Ganz and Co.'s patents for Austria.

The Town Council of Vienna have decided to partially light up the Town Hall with glow lamps, and have given Messrs. Egger and Co. the order.

The electric transmission of power to long distances has been making rapid progress in Austria-Hungary, as may be seen from the following account of work at present in hand or recently completed. Herr Kapferers' paper mill at Waltens is receiving an installation for supplying motive-power to the whole of the works. A 60 horse-power turbine, driven by the Waltens stream near Innsbruch, actuates a dynamo generating current at 500 volts. The current is taken by overhead wires to the mills, a distance of about six miles. Another interesting installation is that in connection with the Wiener-Neustadt Brewery, where both light and power are supplied by means of alternate-current transformers. The water-power available is 80 horse-power. There are 200 glow lamps installed, in addition to two motors of 10 horse-power and one of 5 horse-power. The generator is a Ganz machine, giving 25 amperes and 2,000 volts, and running at 500 revolutions per minute. The two 10 horse-power motors run at 830 and the 5 horse-power 1,250 revolutions per minute. The distance between generating station and the works is 1½ miles. Another plant, not yet erected, but which is in progress, is for the saw mills of Herr Glesinger, in Ober-Turtschek, near Kremnitz, Upper Hungary, where both electric light and power will be furnished by a constant-current machine. There are to be 50 glow lamps and two arc lamps. A fixed electromotor of 2½ horse-power is to be used for drawing the sawn wood by means of a drum a distance of about half a mile to the railway station, which is at a higher level.

NOTES FROM BRUSSELS.

(FROM OUR CORRESPONDENT.)

BRUSSELS, *June* 4, 1889.

The Société Industrielle d'Électricité de Bruxelles is in liquidation. A company calling itself the Société Anonyme Belge pour l'Eclairage Public par l'Électricité has just been formed, with a capital of 250,000fr., in 500fr. shares, to carry out general electric lighting and transmission of power work. The company also proposes to amalgamate with other electrical concerns and to form small local subsidiary companies.

The railway station at Esschen, a small town of 4,000 inhabitants, situated close to the Dutch frontier, has recently been provided with the electric light. An enormous and ever-increasing cattle traffic passes through this station, and a better light than that given by the old-fashion petroleum lamps was urgently needed. The installation was undertaken by the Société Électricité de Hydraulique, of Charleroi, and comprises a Thomas-Laurenz boiler, an engine of MM. Carels Frères, of Ghent, and two 4-pole compound-wound Dulait-Gülcher dynamos. These machines have an output of 150 amperes and 70 volts, and run at 380 revolutions. The lights at present in use are six 12-ampere and four 8-ampere arcs, placed respectively 53ft. and 33ft. above the rails. A large increase in the number of lamps will shortly be made. Every post is provided with a Melsens lightning conductor, and the leads are of bare copper wire, except near the posts. Whenever a lamp is extinguished or gets out of order a bell is rung in the dynamo room, and the needle of an indicator points to the defective lamp.

CORRESPONDENCE.

THE FUNCTION OF THE CONDENSER IN AN INDUCTION COIL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I feel some hesitation in venturing to question any results of a theoretical character which have been obtained by Dr. Fleming, but, as I have some doubt whether his investigation of the function of the condenser in an induction coil exactly meets the conditions, I beg to trouble you with the following view of the matter:—

Dr. Fleming has assumed a primary with capacity at its ends, a secondary with no capacity at its ends, and the possibility of the existence in the secondary of electrical oscillations, *i.e.*, he has assumed that a current can pass in the secondary. If the ends of the secondary are open and have no capacity, then no current can pass at all until sufficient E.M.F. is developed to break through the air, and what happens after this is of little consequence. What is required is to make this E.M.F. as great as possible, and this is accomplished by retarding the primary current as much as possible. Now, without a condenser the primary when broken leaps across the infinitely narrow space at the break, starting a spark which it maintains during its decay—a spark of comparatively small resistance, which requires for its passage by the current a small E.M.F., and therefore $L\frac{di}{dt}$, which is this E.M.F., is also small. Since then the E.M.F. at the terminals of the secondary is also proportional to $\frac{di}{dt}$, so long as no current passes the E.M.F. in the secondary is also small.

Now let the condenser be inserted. Then, as before, the E.M.F. developed in the secondary, which determines whether a current shall be started or not, is proportional to the highest rate of change of the primary. The condenser will only be of service from this point of view in so far as it makes a higher rate of change possible. If it were not for the spark at the break the greater the capacity of the condenser the lower the rate of change; so if it were not for the spark the condenser would do harm, not good. What I have always believed to be the function of the condenser is this:—At the absolute instant of breaking, the current from the primary is diverted into the condenser, so that the E.M.F. between the terminals of the primary does not rise at the rate that it would have done had there been no condenser, and therefore the spark at the break is not started until the contacts have already become

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separated. It is possible then for the rate of change of the primary to have a higher value before it can produce a spark at the break. If the capacity were sufficient of course no spark would be formed there at all. The production of a spark at the break is determined by the relation between the increase of E.M.F. at the terminals of the condenser, which depends only on the original current, the capacity and the self-induction, and the increase of E.M.F. that would be required to start a spark in the growing space between the contacts. The first of these follows a harmonic law, and the second a law in which, approximately at any rate, the E.M.F. is proportional to the distance *plus* a constant. If the E.M.F. of the electrical oscillations at any time catches up that which would be required to make the spark, the spark will be formed, after which the rate of change of current strength will cease to be very great. The longer this spark can be deferred the greater will be the E.M.F. required to produce it, the greater will be the rate of change of the primary current, the greater the E.M.F. in the secondary, and therefore the greater the distance across which a spark can be started by the secondary.

The volume of a spark, assuming that a spark can be formed, is no doubt closely connected with the quantity of electricity passing through it. This quantity will, of course, when the primary resistance is so small that a great many oscillations would be possible if it were not for the secondary, be greater with a condenser at the break than without, and this I believe to be the gain that Dr. Fleming has found.

As the above is the explanation that I have always given, I should be much obliged if Dr. Fleming or any other learned correspondent would look at the matter from this point of view, and correct me where I am wrong.—Yours, &c.,

C. V. BOYS.

RE "SHEET LIGHTNING" (?).

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am able to confirm Mr. Larden's conclusions by observation as recent as yesterday.

At 9:45 p.m. yesterday evening, looking due north, I observed a flash of sheet lightning which was traversed by five pale sparks passing vertically to the horizon, which was distant from me about a mile, and subtending an angle of about 4deg. I listened carefully for any sound, but was unable to hear any; the paleness of the sparks suggested that they were at a considerable distance.

Several more flashes followed, more or less shielded from view by clouds, but unaccompanied by any sparks or sounds.—Yours, &c.,

JUSTUS ECK.

St. Peter's College, Cambridge, June 3, 1889.

COMPANIES' MEETINGS & REPORTS.

The National Telephone Company (Limited).

The ninth annual ordinary general meeting of the shareholders was held at the City Terminus Hotel, on Tuesday, Colonel R. Raynsford Jackson, the Chairman of the Board, presiding.

Mr. WILLIAM B. CAMPBELL (the Secretary) read the notice convening the meeting. The report and accounts were taken as read.

The CHAIRMAN: I am glad to see that a much larger number of shareholders than usual attend this meeting. I can well understand the reason of their doing so. We have not to deal only with the ordinary business of the Company—that is, to ask your acceptance of the report and the declaration of dividends—but we have also to consider an important scheme of what is practically amalgamation, but which has taken the form of the purchase by the National Telephone Company of the United and Lancashire and Cheshire Companies. I will, however, in the first instance, briefly refer to the report, as it concerns the working of the National Telephone Company proper for the last ten months. I am happy to say that that has been for the Company a prosperous period. We have increased our number of subscribers by 1,489, the total now being 10,813. We have increased the mileage of our trunk wires by 1,238 miles, the total being 3,747 miles. The total mileage of the company's wires is 13,533 miles, and the gross revenue of the Company is now, or rather was on the 30th of April, £125,978. 3s. 1d., the increase for the ten months being £16,405. 10s. 6d., or at the rate of close upon £20,000 per annum. This is the most considerable increase in revenue that the Company has ever managed to secure. We have increased the exchanges of the Company by 18, making the total number 135, and the call offices by 61, making the entire number 277. The net revenue earned for the ten months is £42,338. 1s. 1d., or at the rate of close upon £51,000 per annum. After paying the Preference dividends, the interest on the debentures, and the sum of £3,502. 17s. 9d. due upon old accounts to the United Company with reference to royalties, there is left £24,952. 17s. 9d., which we propose to use as follows:—£9,000 was paid as an interim dividend to the Ordinary shareholders. We propose to make up the dividend for ten months to the rate of 5¼ per cent. per annum, and that will absorb £10,687. 10s. We further propose to put £2,500 to reserve, and to carry forward £2,765. 7s. 9d. I may explain that of the construction outlay, which you see by the report and the accounts for the ten months was £52,747. 0s. 5d., over £16,000 was devoted to the construction of trunk wires, and, as I told you before that we had increased our trunk wires by 1,238 miles, you will understand at what cost the additional trunk wires—a system most important to the interests of the Company and to the public—have been created. You will say if we have been so prosperous—and I assure you that the prospects of the National Company proper are still extremely good—why do we favour amalgamation? We have, as we think, quite sufficient reason to favour amalgamation, and the directors of the Company who remain on the Board are quite satisfied with the terms which have been arranged with the other two companies which are to join in this great and important undertaking. We favour amalgamation for a variety of reasons. In the first place, we think that a necessary consequence will be a great reduction in the aggregate expenditure of the combined companies. You can quite understand that that great reduction of expenditure will be very beneficial to the interests of the shareholders. We think also that we should profit by the experience which has been separately acquired by all the companies joining in the amalgamation, and that we shall be enabled, therefore, to give to the public a better service all round than at present, and that we shall also be able to meet the wants of a variety of interests which, to a certain extent, are now neglected. Bear in mind also that the National Company was in relation, and is at this moment in relation, to the United Company in a peculiar position which may or may not be beneficial to its interests, and which could not be, I think, maintained without detriment to them. The United Company has half the voting power in most of the sub-companies, the National Company amongst them. The sub-companies cannot issue additional capital without the sanction of the United Company, and they are limited in the form of issue they adopt by the will and pleasure of that Company. Now I do not think that any shareholder will be indifferent to the fact that by the amalgamation we get rid of the powers of the United Company with reference to our enterprise, and that we form part of a combined Company which is under no such control. Our hope is that the result of the amalgamation will be to make London the heart and centre of a huge telephonic system, embracing its own suburbs and such of the industrial towns of the United Kingdom as may desire to have constant and easy telephonic communication with it. We hope also, as regards the provinces, that the existing extensive trunk communication which unites many of the towns in the provinces will be greatly improved and extended; and as between the towns in the territories controlled by different companies, we have no doubt whatever that the effect will be to save a great waste of time in negotiation, and to supply trunk services running in the direction that is most consonant to the interest of the public, and best for that of the shareholders. I have no doubt that our enterprise will popularise the telephone—will bring, on the part of the public, a greater feeling of cordiality towards telephonic enterprise and to those who wield it, and that the result will be largely beneficial alike to the shareholders and the public. Most of you have received a circular signed by Colonel Williams. I will offer but a few observations on that circular. This is the one dissentient note in our proceedings. The Secretary has read to you the number of proxies which the Directors have received, and I am happy to be able to inform this meeting that Colonel Williams's circular has not caused the withdrawal of one single proxy, and that the number supporting him—the proxies which he has been enabled to send in—are received from five shareholders, and represent 275 shares. In one paragraph of Colonel Williams's circular he says that the voting to-day will be a farce; that the United Company, in fact, will control the meeting; that the United Company's vote is the sole power—for that is practically the meaning of the paragraph—upon which the Directors rely for carrying out its designs and intentions with reference to amalgamation. Well, the fact is that, laying aside altogether the vote of the United Telephone Company, the Directors have received proxies for 34,494 votes. A three-fourths majority of the shares outside those held by the United Company would be 33,750. The Directors, therefore, have received more than a three-fourths vote, leaving out altogether the United Company's voting power. The Directors have also received proxies which are too late to the number of 945, but, at all events, we may judge of the views of the shareholders who sent those proxies if we cannot count their votes in case of a poll. Then Colonel Williams seems to be in a state of great alarm as to what the Post Office may do, and in what direction it may show resentment at the amalgamation of the three companies. I feel no such apprehension. The Postmaster-General no doubt will be influenced by motives of policy in the course which he pursues. He will not be stimulated by feelings of resentment or indignation because the companies have taken that course which they think best for their own interests. I know well what the action of the department has for years past been in reference to the Telephone Companies—at all events, in reference to the National Telephone Company. Its action has been fair and liberal within the lines laid down and imposed upon us by the License under which we work. I know that the head of that department is a fair-minded and honourable man, because I have had experience of his being so, and the head of the Telegraph Department, who has the principal share in dealing with the Telephone Companies, is also a fair and liberal-minded man, and I apprehend nothing whatever from any illegitimate hostility on the part of the department. I can well understand that if the Postmaster-General either

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thinks of hereafter buying the Telephone Companies, or some day or other extending his own system in opposition to the Telephone Companies, it will suit his interest better that they should remain distinct, unable to act with vigour, rapidity, and intelligence, and that he should be able to deal with them piecemeal. But although he may have that feeling you cannot suppose that a man holding his position in a powerful Ministry would stoop to any indirect action or interference in his dealings with the Telephone Companies, so I conclude we may dismiss altogether the scare which Col. Williams has attempted to impress upon us in his circular. Well, then, there is an extraordinary paragraph in the circular in which he talks of the large bonus which is to be received by the United Telephone Company and the bonus to be received by the Lancashire and Cheshire Company, and the absence of any bonus to be received by the National Telephone Company. He has called the bonus a bogus capital, but I have yet to learn that the legitimate earnings which are derived from the working of any enterprise and the additional increase consequent in the value of their assets is to be regarded as bogus capital. The value of the shares of the three companies has been fixed by the public, and the basis of our amalgamation is the public view of the value of those shares. The National Company could not under any circumstances, as the purchasing company, give itself a bonus, but the companies have been taken over at the relative value they held in the market at the time the amalgamation was fixed upon. I do not think it is necessary to go further into detail on that subject. I think it is very possible that Col. Williams may make an attempt hereafter to enlighten you, and I hope every attention will be given to what he may have to say on this important subject. But there is one other paragraph in his circular with reference to which I would like to say a word or two. He speaks of Messrs. Carter and Carter, and he calls them independent and disinterested experts. I have no doubt he is perfectly right in that expression. He speaks of myself and those who he supposes have negotiated the terms of this amalgamation as neither independent nor disinterested. I am sorry that Colonel Williams has seen reason to change a strong opinion he held in reference to myself, which he expressed in a letter to me upon the 6th April. I will read you the letter. It is short. It is pithy. It is wonderfully well expressed, and I believe it contains—I am convinced it contains—the honest sentiments which influenced Col. Williams at that time, He said then, "I have your letter *re* amalgamation, and will be with you at your informal conference the day before the meeting on Saturday the 11th. It would of course be absurd on my part to offer anything worth calling an opinion upon details which need so much earnest study to master and then to weigh as those which had been occupying your time and attention almost exclusively for months past. As I know and feel that your judgment in such matters is exceptionally strong and sound, and that you have nothing more at heart than the interest of the Company, the success of which is mostly due to your perseverance and skill, whatever you recommend I shall heartily support." He goes on to say: "Of course I see that the scheme involves my own eclipse, and I frankly own that I shall regret to have to disappear, but I have never let personal considerations weigh with me for a moment in a question of this kind, and I accept beforehand your recommendation whatever it may be." Col. Williams will probably when he addresses you explain his reason for the great change in his opinion since then. I must confess that I regret he has seen reason to change his opinion. I doubt whether he will be able to convince you that he was justified in making that change. Before I sit down I will tell you briefly what the capital of the reconstructed company will be. You are aware that the first intention was that the shares of the United Telephone Company should be taken at £15, the Ordinary shares of the National at £6, and the shares of the Lancashire and Cheshire at 31s. 6d. When the Postmaster-General refused to grant the License to the new company to which the property of these three companies was to be transferred we had to consider whether we could still arrange the combination which we thought so essential to telephone interests, and it was decided at last that the National Telephone Company could not increase the value of its own shares from five to six pounds, and it was arranged, therefore, that one-sixth should be taken off the price originally intended to be given to the other two companies, and the result of that arrangement is this: that the United will receive £1,250,000, the National £720,000, the Lancashire and Cheshire £525,000. When I say that the National will receive, I should say that the National has and that the other two companies will receive the amounts I have mentioned; but the United Company hold shares in the National and Lancashire and Cheshire Companies, and the amount allotted to it includes the value of those shares. They are also included in the statement I have given you in the amount of the shares designated as belonging to the Lancashire and Cheshire and National Companies. They will have to be deducted from the total sum which I have put before you. The shares the United holds in the National Company are 45,000 £5 shares, at a value of £225,000, and in the Lancashire and Cheshire Company 50,000 shares at a value of £65,625. These two together make £290,625, so that the amount of the capital of the three companies in the first instance will be £2,204,375. I do not know, gentlemen, that there is any occasion for me to occupy your time longer, and I will now content myself with moving the adoption of the report.

Mr. JOHN BRUCE seconded the motion, which was carried unanimously without discussion.

The dividends recommended at the rate of 6 per cent. on the Preference shares and of 5¼ per cent. per annum on the Ordinary shares, both for the ten months to April 30, were declared.

Mr. JEREMIAH GARNETT moved the re-election of Colonel Jackson as a director.

Mr. PETER GARNETT seconded the motion, and it was carried.

The CHAIRMAN, in returning thanks, explained that the term of office of the Directors would be a very short one if the amalgamation were carried through, because the amended Articles of Association provided for a new Board. The Chairman then moved the re-election of Mr. W. H. Bradbury as a Director.

Mr. P. GARNETT seconded, and the motion was adopted.

On the motion of the CHAIRMAN, seconded by Mr. S. H. SANDS, Mr. William Lowson was also re-elected a Director.

The auditors, Messrs. Welton, Jones and Co., were likewise re-appointed.

The CHAIRMAN: The next resolution which I have to propose is the following:—

"*That the following agreements be and the same are hereby adopted and confirmed, namely, an agreement made between the United Telephone Company (Limited) of the one part and this Company of the other part, for the transfer of the United Company's business and certain property to this Company for shares in this Company, and also an agreement made between the Lancashire and Cheshire Telephonic Exchange Company (Limited) of the one part and this Company of the other part for the transfer to this Company of the business and certain property of the Lancashire and Cheshire Company for shares in this Company*"

Now, gentlemen, having said what I thought it expedient to say on the question of amalgamation, I will simply propose that resolution.

Mr. PETER GARNETT seconded the proposition.

Col. WILLIAMS said that in discussing this question the first thing they had to settle was what was meant by the National Telephone Company. The term was a very simple one, but it covered more than one meaning. It meant, on the one hand, a group of *bonâ fide* investors who were not engaged in any financial or other operations with any other company, and, on the other, it meant a group of financiers who had practically the command of the telephone system of the United Kingdom, and the interests of these two bodies were not only distinct but they were antagonistic. The antagonism remained dormant so long as the question of amalgamation was not brought to the front, but it became acute as the negotiations progressed. The interests of the two groups were so diametrically opposed that it was impossible for a Director to serve both parties fairly. That being the case it was perfectly natural that Colonel Jackson should be rather shocked that a Director of this Company should run counter to the interests represented by the group he was serving; but it was just as natural for him (the speaker) to be astonished that the Chairman of the National Telephone Company should disregard the interests of those who had invested money in it as *bonâ fide* shareholders. Colonel Williams went on to refer at length to the course of the negotiations, and said he had at the meetings at which the matter had been brought forward, objected strongly to the amalgamation, on the double ground that it would run counter to the Post Office Authorities without producing any compensating advantages for the shareholders. Colonel Harrison, whom he regretted not to see present, opposed the scheme on its merits, while he (the speaker) having no data upon which to discuss the scheme from that point of view, had opposed it because of its impolicy. But besides that another Director had told him in conversation that he would oppose the scheme if he were independent, but that if he had to be executed he would prefer to chose his own method than submit to the caprice of an executioner. It was clear to him that the Board were under the thumb of the United Company. The terms were, in fact, settled by Colonel Jackson, although he only had authority to get matters sufficiently forward for the Board to discuss them. He could quite understand that if there were any great advantages to be obtained by the amalgamation the opposition of the Post Office might be set aside, but he saw no such advantages, at all events for this Company. Indeed, he considered it monstrous that the United Company should be given two and a-half shares in the amalgamated undertaking for every share held by the National Company. He had invested his money in the Company believing it to be thoroughly sound, and he would be prepared to double or treble his interest if the scheme were withdrawn; but if it went on he would sell his shares at any sacrifice, and he would advise others to do the same, for the bargain proposed was a most inequitable one.

Mr. W. A. SMITH (Glasgow) said that as Colonel Williams had made rather a point of representing the outside shareholders of the National Telephone Company, he (Mr. Smith) thought he might claim attention for a moment, as he represented between a fourth and a fifth of the investing class of shareholders, which was a much larger body than Colonel Williams represented, and in carrying out their views he wished to speak strongly in favour of the amalgamation taking place. He had listened with great patience to Colonel Williams because he was sure what he had said had been said with sincerity; but he was equally sure that Colonel Williams had not devoted sufficient time and attention to be able to fairly discuss such an operation as this. He (the speaker) had gone most carefully into all the figures. Colonel Williams represented that the patents of the United Company would run out in about two years, but it was to be remembered that the value of any successful patent was greater in the last two years of its existence than in the first seven. The United Company owned territory that could be made exceedingly valuable. It was well known that the United Company's Board was composed of men of undoubted talent, but the time of most of those gentlemen was taken up with other matters. Under the scheme of amalgamation, however, they would have a thoroughly representative Board, and if they had proper management he had no doubt they would all have reason to rejoice that the amalgamation had taken place. By the courtesy of the Post Office authorities he had inspected their two exchanges, one in Newcastle and the other in Leicester. The Newcastle exchange appeared to be the supreme effort of the Government department, but it was a poor thing, from which they would have nothing to fear, while the Leicester exchange was a perfect *fiasco*. He trusted that the meeting would unanimously—at all events, with the exception of Colonel Williams—support the Board in this amalgamation, and he suggested that in sending out notices for the confirmatory meeting they should give some fuller particulars of the advantages to be gained by

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the scheme, feeling that if that were done the shareholders would cordially support the Directors.

Mr. J. GARNETT: As I am the Director whom Col. Williams met at the Reform Club I would like to say a few words with reference to that conversation; but before doing so I would like you to understand that it is usual when a man is taken up for any crime for the policeman to caution him when he speaks that whatever he may say will be taken down in writing and used in evidence against him. But I am not the only gentleman that Col. Williams has done the same thing to. What I did say was this: "I believe the National Telephone Company is by far the best of the three," and I think so still. I believe that we have districts which are far more capable of being improved than either the United or the Lancashire and Cheshire, and I said "I did not think we should ever get the price that I should put upon it. Some of us, you in particular and myself, may have to retire from the Board. We are going to be executed, so we may as well assist at our execution and get it over as easily as possible. I shall go to the Conference and try and get for the National the best possible terms we can get, and I recommend you to do the same." Col. Williams may well know nothing about the negotiations, for he kept out of them consistently. He had an invitation to go to these hole-and-corner meetings that he suggests were held; he was invited to see everything that passed, but he declined to go. I think when the United Company say they have been sold, and the Lancashire and Cheshire declare they have not got what they ought to get, we ought to be pretty well satisfied with the arrangement.

Colonel WILLIAMS said the greater part of the conversation described by Mr. Garnett was purely apocryphal. The account he (the speaker) had given of the conversation was absolutely correct.

Mr. GARNETT denied this, and reiterated that he had stated with practical accuracy everything that he had said upon the occasion referred to by Colonel Williams.

The CHAIRMAN: I shall not detain you by making any lengthened reply to Colonel Williams' observations. I will merely point out that in a few of his facts, which certainly would be important if correct, he is altogether mistaken. He talks about two financial groups, and says he has discovered or has been told that the shares of the Company are held mainly in a few hands. I have before me here a list of the ordinary shareholders of the Company. I have not before me now a list of the preference shareholders, but there are 480 ordinary shareholders in the Company, and the shares are distributed very widely. Many holders have a very few each, and no single holder outside the United Telephone Company has above 1,500 ordinary shares except a bank, and that bank holds the shares of other people, and has sent its proxy in accordance with their desires and instructions. Then, Col. Williams says he has had no opportunity of understanding what was going on with reference to amalgamation. At every meeting of the Board I have entered into explanations upon that subject, and a resolution was passed desiring me to continue the negotiation, and when it had arrived at such a point that I should be able to state what financially and as regards its organisation was proposed, I should then explain the features of the negotiation to the Board. We had lengthened negotiations before we arrived at that point, and as soon as we had arrived at it I took the Board into my fullest confidence. Then he says in his circular that I alone represented the National Telephone Company. I have been assisted at various times by other members of the Board in my conferences with the directors of the other companies—both the Messrs. Garnett, Mr. Sands, and Mr. Bruce have all attended these conferences with me from time to time, and when the most important conference of all took place those four gentlemen were, as well as myself, present. Then Colonel Williams says that only two gentlemen from the United Company took part in those conferences, and two from the Lancashire and Cheshire did so. It so happens that the whole of the Board of the Lancashire and Cheshire Company was present, and generally three or four of the United Telephone Company, so that Colonel Williams has not been quite so careful in ascertaining the correctness of his facts as when intending to address a meeting of this importance he should have been. I shall not further enter into the matter.

The resolution was then put and carried, Colonel Williams being the only dissentient.

The CHAIRMAN: The next resolution I have to propose is:

"*That the capital of the Company be increased by the sum of* £3,250,000 *by the issue of* 650,000 *shares of* £5 *each.*"

Mr. JOHN BRUCE seconded the resolution, which was carried.

The CHAIRMAN also proposed:

"*That the regulations of the Company be varied by substituting for the existing Articles of Association the Articles a print of which is now submitted to this meeting, signed for verification by the Chairman of the meeting and the Secretary, and that such last-mentioned Articles be the regulations of the Company in the place of the existing regulations.*"

Mr. J. GARNETT seconded, and the proposition was adopted.

The CHAIRMAN: I may inform you who are to be the new Directors of the amalgamated company. They will be Mr. Charles S. Agnew, who is a representative of the Lancashire and Cheshire Company; Mr. John Winterbottom Batten, one of the United Company's Directors; Mr. James Brand, the present Chairman of the United Company; my friend Mr. John Bruce, Mr. James Staats Forbes, the Vice-Chairman of the United Company; Mr. Peter Garnett, a Director of the National Company; Mr. Eli Heyworth, one of the Lancashire and Cheshire Directors; myself; Mr. F. R. Leyland, a Director of the United Company, who is largely interested in our own Company; Mr. J. B. Morgan, Mr. Dillwyn Parish, and Mr. W. C. Quilter, M.P., all of the United Board; Mr. G. H. Robertson, Mr. Samuel Herrick Sands, and Mr. Alderman Joseph Thompson. Seven of the directors will represent the United Company, four the National, and four the Lancashire and Cheshire. The Chairman then moved a resolution removing all the existing directors of this Company as from the date of the confirmatory meeting.

Mr. FREDERICK R. LEYLAND, in seconding the motion, said that although he represented the United Company on the National Board he had a larger interest in the latter company than in the former. He quite agreed with everything that fell from the Chairman as to the desirability of this amalgamation, and he could from personal knowledge vouch for the absolute truth of what had been said in support of the scheme. Unlike Colonel Williams, he had been present throughout the negotiations. All the new Directors would have an enormous stake in the new National Company; they would represent an interest of £350,000. What better guarantee than this could the shareholders have that these gentlemen would attend to their own interests?—and their own interests were precisely the same as the interests of the general body of shareholders. Colonel Williams said the new Company would be dominated by a group of financiers. He did not quite know what this meant, or to whom Colonel Williams referred.

Colonel WILLIAMS: I spoke on the authority of Colonel Harrison.

Mr. LEYLAND thought it would be better if Colonel Williams spoke from information within his own knowledge; but instead of doing so he always expressed the strongest possible opinions, and adhered to them, without having any knowledge or information upon which to base his statements. The negotiations were perfectly open to Colonel Williams, and yet that gentleman had roundly charged the Chairman, behind his back, with having sold the National Company. Indeed, he now insinuated the same thing, though in much more guarded terms. But what interest could Colonel Jackson possibly serve in selling the Company? He had no interest in the United Company, and his whole reputation was involved in this Company. It was cruel for Colonel Williams to make these unjust accusations without any foundation beyond his own diseased imagination. The Chairman had said nothing in his own defence; he was quite willing to leave his character in the hands of the shareholders and of the Directors, who knew and appreciated his great services to the Company. Colonel Williams seemed to forget that the United Company not only had its exchange business, but that they had their royalties for two years longer. Was that worth nothing? Last year the royalties amounted to £45,000. Besides that the United Company would bring in their shares in the subsidiary companies, which were valued at over £400,000. That was what Colonel Williams called bogus capital and premiums. Why, they were *bonâ fide* assets worth golden sovereigns in the market. The negotiating Directors looked sharply after the interests of their own companies, and each man tried to do the best he could for his own company. In this matter the Chairman of the National Company was certainly not behindhand. As to the statement that they were defying the Post Office, that was absolutely fallacious. They were merely trying to give an efficient service at the cheapest rate possible, so that the Company should be defended from competition by the Post Office or by anybody else, or should, at all events, be able to face without fear any competition which might be forced upon them. Colonel Williams had also stated that the National Company had been terrorised and menaced by the United Company; but that was a pure myth. He said this with some authority, for he had been present at every meeting, whereas Colonel Williams, who made the charge, was not present at any of them.

Mr. J. S. FORBES: If anybody knows anything about this matter it is myself, for I have been entrusted by the United Company with the leading oar in the negotiation. I shall not refer to Colonel Williams, for I think his position is sufficiently unfortunate. He has ventured to make statements without knowledge and upon hearsay, and I think he cuts rather a sorry figure now he is exposed. Perhaps he will go away from this meeting having learned a lesson; let us hope so. But in case there should remain the possibility of his circular affecting the mind of any shareholder in the National Company as to its being a bad bargain for him, perhaps it will be a consolation for you to know that I, for one, think they have got the best of it. I most reluctantly consented to the terms being accepted for the United Company, for I was quite satisfied that the United Company got the worst of it. But, oddly enough, when we came to talk to the Lancashire lads—they are largely interested personally in the matter, and are generally credited with knowing how many shillings there are in a sovereign—we found that the cleverest man amongst them and the most obstinate was still dissatisfied; so that it comes to this: The National have made a very bad bargain in this amalgamation, the United have made a very bad bargain, and the Lancashire and Cheshire have made a very bad bargain. Now, my induction from that, as a man of the world, is that you can depend upon it when every party to a bargain is dissatisfied it is about the right thing all round. I commend that to your consideration. I do not think it necessary to deal further with that matter; but I must say a word or two as to the personal aspersions on Colonel Jackson. Colonel Jackson knows that about myself there has been no sentiment in the business, and I have appreciated as much as any man can do, not being a shareholder in the National Company myself, the great services he has rendered to your Company, because I am satisfied that, first of all in building it up and giving it a market value and, defending by argument and tenacity that market value, he has done you in the carrying out of your undertaking enormous service. It is greatly to his personal merit and attention that you owe the fact of the present market value of your property, and, lastly, he has secured for you an exceedingly good bargain. Then, about the Postmaster-General; let us get rid of all that. I know the Department pretty well, and I have the honour of the personal acquaintance of the Postmaster-General. He is only doing his duty in protecting his interests, but I agree with the Chairman in thinking that the Postmaster-General could not descend to being influenced by any feeling of anger because you are protecting your interests and availing yourselves of your legal right. You cannot go outside it, so you may get rid of any idea that the Postmaster-General is going to be greatly offended. If he should be weak enough to be offended you may get rid of any fear that that would influence your future. You have an enormous business, and the reason that the amalgamation is likely to be

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useful is that when the patents expire you will be able to protect yourselves against the competition of the Post Office or anybody else. The patent is sufficiently protected to enable you by a judicious expenditure of capital to put your house in order, and with the knowledge we have of this enterprise—knowledge which nobody else has of this business—to place yourselves in such a position of security that when the time comes for open competition you can defy not only the Postmaster-General and the Department but any outsider also.

The resolution was then put and agreed to *nem. con.*

The CHAIRMAN then proposed the fourth resolution:

"That in order to give effect to the regulations of the Company all the Directors holding office prior to their adoption be removed from office."

This resolution was seconded by Mr. SAMUEL H. SANDS and carried.

On the motion of Mr. FITZGERALD a cordial vote of thanks was passed to the Chairman and the Board of Directors.

The CHAIRMAN acknowledged the compliment, and the meeting then closed.

United Telephone Company.

The ninth annual general meeting of this Company was held at the City Terminus Hotel on the 4th inst., under the presidency of Mr. James Brand.

The SECRETARY (Mr. Thomas Blaikie) read the notice convening the meeting.

The CHAIRMAN said: Gentlemen,—During the last few months your accounts have been subjected to very severe inspection by our two subsidiary companies with whom I hope you are now going to amalgamate, as well as by our own auditors. They have all agreed that we can pay you a dividend of 17½ per cent. while we increase your reserve fund by about £10,000, arising from premium on new shares issued. Your share capital is now £500,000, against £483,000 last year. This is an increase of £16,500, partly owing to the amount called up on the new issue of shares after the end of our last financial year, and a further issue since of the remaining 978 shares. On the whole of this amount the 17½ per cent. dividend has to be paid, making an increased payment to the shareholders of over £9,000. As to revenue, we carry forward £4,000 more of unearned subscriptions for the benefit of next year. I will not say any more as to the accounts just now, but by-and-bye will be happy to answer any question that may occur. I will say a word or two as to what we have been doing, and then get on to the resolutions for amalgamation. To meet the wishes of many subscribers we have established an all-night service throughout the West End of London, Chancery-lane, King's Cross, &c. At present this means chiefly an increase of expense, but we hope it will more and more prove the usefulness of the telephone and add to the number of our subscribers. So far the calls have been very few, but they are gradually rising, and last week they averaged 123 per night between the hours of 9 o'clock p.m. and 9 in the morning, and on Sundays 216. We have now 28 call rooms in and about London open. We have nine more to be opened shortly, and we have concluded an arrangement with the Aërated Bread Company which will very soon cause the opening of something like 80 fresh call rooms in the most frequented places in London. A local exchange has been opened at Bromley, in Kent, which is now being joined to our London system by trunk. We have already an independent trunk line between London and Croydon, and a local exchange with 42 subscribers. The number is few, but we have worked very hard to get them. To encourage the enterprise we have put the Croydon people on the system, and joined up the medical men free of charge. The Brighton business in itself is, I believe, doing very well for the South of England Company, but we have not had the success we hoped for as far as the inter-communication with London is concerned. We believe this to be owing to the uncertainty of our wire. This was put up on the ordinary railway telegraph poles by the General Post Office. It has cost us a good deal of money, which except as a useful experiment has been more or less thrown away. The South of England Company has now entered into a special arrangement with us for the purposes of a call room between London and Brighton. The route has been surveyed and the work begun, so that we may join our Croydon trunk wires on the Brighton direct or special poles, which will be free from induction, and we hope to induce a large telephonic business between London and Brighton and the intermediate towns. I am glad to tell you that we have acquired space within the Stock Exchange of London, and are erecting a special trunk line between the Stock Exchanges of London, Liverpool and Manchester, entirely for the use of the members of these Exchanges. Our trunk is now complete for nearly 94 miles between Birmingham and London, and, barring the difficulty of getting way-leaves about Hampstead, the London end will be complete in a week or two. The road to the north of Birmingham is being surveyed. Through the National Company's wires now in existence beyond Birmingham we hope to put the Stock Exchanges in communication very shortly, and to put them in perfect communication by the special trunk in a few months. If this line is a success, as I fully believe it will be, it will have a very valuable effect on your property, or rather, as I hope, on the property of the Amalgamated Company. At the date of the general meeting last year we had obtained an interim injunction against the Equitable Telephone Association, restraining the use of the Campbell-Swinton Telephone, and the defendants in that case threatened to fight the whole question of the validity of the patents, as also the question of infringement. But I am glad to say that they thought better of this, and in December last they submitted to a perpetual injunction with the usual terms, surrendering all instruments in their possession, and giving particulars of all instruments supplied. The Company speedily went into liquidation. We have since had to take action against the New Telephone Company, to restrain the manufacture and sale of Silvanus Thompson's Valve Telephone. In this case again we were threatened with a heavy fight, but after we had given notice of motion for an interim injunction they surrendered at discretion, and the result has been the same as in the case of the Equitable Telephone Company. The Court made a winding-up order against them on Saturday last, and I am afraid that the people who have been buying instruments from them on the faith of their indemnity will find their indemnity of very small value. We have, as you are aware, throughout adopted the policy of waiving proceedings against purchasers and users of these instruments on their giving up the offending instruments. Some 2,000 instruments have been surrendered during the past twelve months, and the various district companies have in very many cases supplied licensed instruments in their place. It is not a very wise thing to prophesy, but I really think that in the face of the complete collapse of these infringing companies, leaving their guarantees unpaid and their shareholders with a total loss of their capital, we are not likely to see any similar company started during the remainder of the terms of the patents. You will wish now to come to the question of amalgamation, which is the most interesting question to-day, and I shall have this afternoon to propose some resolutions, which I hope you will pass, to enable us to carry this amalgamation into effect. We first considered this matter about two years ago, and as time went on it became more and more evident to us that amalgamation is the right course for us to pursue if we want to turn our investment in telephonic enterprise into a really high-class security or property. When first we entered into this enterprise we found that our one combination was not sufficient to carry on and develop an entirely new business all over the country at once, but that to enable us to cover the ground without delay it was necessary to divide and scatter our forces all over the country as much as possible, and to enlist the interest and sympathy of all classes of people and in every centre of population and industry. This was done by the establishment of the Lancashire and Cheshire Company, the National Company, the Western Counties Company, the South of England Company, the Northern, and the Telephone Company of Ireland. These companies have excellently proved the wisdom that dictated their formation, and the various towns all over the country are now more or less feeling the benefits of telephony. But the division of the country and the districts in which the United Company and its subsidiary companies are allowed to carry on their business has given rise in many instances to differences of opinion and complications, which has rendered it necessary to come to special agreements when we have wished to put towns and districts and systems in direct communication with one another. By the union all these difficulties and differences will be overcome, the work will be carried out under one management, and when way-leaves have been obtained in the various localities the building of the trunks will be more rapidly carried out. Economy in management will result, decisions as to policy will be more rapidly arrived at, and more power to our elbows will ensue. Following out the same train of thought, while it was necessary in the first place to distribute our energies by the division of our forces, it becomes, now that our purpose has been to a great extent achieved, desirable in the face of the quick approach of the expiration of our patents to once more bring our components together so that we may make up by the concentration of our forces and our business any loss of power which might ensue from the expiration of our patents. Besides, our friend the Postmaster-General, who in the pursuit of the duties of his office acts as a very keen trader always on the look out seeking whom he may devour, would certainly be more able to bring his devices to pass if he had to deal with the various companies singly and one after another than if he had to deal with one great company, strong in unity, in financial position, and with one strong executive body. I really don't know what more I can say or that it is necessary for me to say to put before you the great advantages of this union in the first place of the United Company and its two elder children. The union will have the same effect as the tying together of the bundle of sticks in the fable. While we are apart anyone can try to break us and interfere with us in many ways, but when we are tied up together we become an altogether article, and much more capable of defence and of resisting offensive treatment by any person whatever. While we are separate we are to a certain extent financially as well as otherwise weak, but when we amalgamate we have much greater ease with finance, and can raise money on much cheaper terms, and our shares, which up to this time have been of a somewhat speculative character, owing to the various difficulties which beset us, become property, according to my mind, of a more valuable kind and quality. We have told you in our notice the reason for uniting the three companies also, under the name of the National Company, instead of, as would have been more natural, the two other companies coming together under the wing of our Company, the United Telephone Company. It is naturally somewhat hard for us to change our name, but we have to look at the welfare of the whole body, and not be guided by our individual feelings. We must, therefore, eat the leek provided for us by the Postmaster-General in declining to grant the United Telephone Company permission to assign its License, which would have obviated this necessity without in any way interfering with the rights and interests of his department or the Government. I understand that the Postmaster-General declined to grant us what we desired on the ground that the monopoly created by such a License and by such acquiescence in our desires on his part as might be implied by such a grant would be contrary to public policy and injurious to the interests of the public by the clearing away of competition. Now, when he said this the Postmaster-General was drawing a red herring across the scent of the public. He knew full well that ever since the granting of the separate Licenses to each company there had been no competition, as each company has worked its own territory without interfering with its neighbour, and have all been working to one end and for the joint benefit of the public, themselves, and the United Telephone Company. Why the Postmaster-General refused to grant the

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permission we asked for is not very clear; but if he had been perfectly frank with us he might have put it somewhat as follows: "You, gentlemen, bought with a large expenditure of your money an entirely novel and most amazing invention. We, the Department, had had just as good a chance of buying this extraordinary thing for ourselves, and so adding immensely to the power of the Department for the public good. However, as we were so shortsighted that we failed to recognise the beauty and value of the thing, we allowed you and your friends to step in and take the invention for yourselves, believing that it was a plaything and you would soon lose your money and get tired of it." As soon as we had proved that it was no plaything, but was going to be a commercial success to the country and a source of profit, he stepped in and said, "Your great invention is only a telegraph, after all. It belongs to us, the General Post Office, and if we allow you to use it you must pay us £10 out of every £100 gross you receive." And a gross thing it was. [Mr. FORBES: "Oh!" (Laughter)] Well, we paid him this enormous tax, amounting now to near, say, £35,000 per annum, which costs him nothing to collect, and now, finding that in spite of this burden placed upon us we are getting stronger and more useful every day, he pursues the old tactics of placing every obstacle in the way of our progress, and reminds me of the wicked husbandmen in the parable, who said: "Here is the heir; come, let us kill him, and his inheritance shall be ours." Gentlemen, the fate of those husbandmen was not a happy one. What he really fears is what we hope, which is that the union of the Telephone Companies will lead to better management, greater economy, and better service to the public, and the possibility in the end of a cheaper exchange system. I think I need say no more to induce you to pass the resolution I have to propose. Remember that union is strength, and in the matter of telephony it means also economy, efficiency, and cheapness. I beg to move the following resolution:—

"That the report and accounts, taken as read, be received and adopted, and that a dividend for the half-year ended 30th April, 1889, of 12s. 6d. per fully paid-up share, less income tax, be paid, making a total dividend for the year of 17½ per cent. on the paid-up capital of the Company."

The DEPUTY-CHAIRMAN (Mr. J. S. Forbes): I beg to second that.

A SHAREHOLDER: Will you take the discussion, if any, on the report separately from the discussion on the amalgamation.

The CHAIRMAN: Yes. The motion is now before the meeting for the adoption of the report and the declaration of the dividend. As many as are of that opinion please signify the same in the usual manner.—To the contrary. Carried unanimously.—Continuing, he said—I have now to move

"That the agreement submitted to this meeting, and expressed to be made between this Company and the National Telephone Company (Limited), for the amalgamation of the two Companies, by a transfer of the business and property of this Company (with certain exceptions) to the National Telephone Company (Limited), in consideration of shares in that Company, be and the same is hereby approved."

That is the agreement for confirming the arrangement that has been submitted to you all in this circular. I do not know that I have anything to say about it more than you have read.

The DEPUTY-CHAIRMAN: I beg to second that resolution.

A SHAREHOLDER: Will there be no alterations in the Articles of Association?

The CHAIRMAN: Oh, yes. They have been exhibited, and are here now—not of our Company, but of the National Company.

A SHAREHOLDER: What are the "certain exceptions" referred to in the resolution?

The SOLICITOR (Mr. Crisp): We do not transfer the License; we do not sell the shares of the National Company which we have, as there would be no object in selling them; and thirdly, we reserve the dividend just declared.

A SHAREHOLDER: What will be done with the shares?

The SOLICITOR: They will be distributed among the shareholders.

A SHAREHOLDER: May I ask if the Postmaster-General can with any effect raise the objection to this amalgamation that it is contrary to public policy, and that we are endeavouring by a side-wind to carry out what he has done his utmost to prevent? There is a question to be asked in the House of Commons to-night.

The CHAIRMAN: We saw that question on the paper too late for us to endeavour to have the effect of such an insidious question neutralised.

A SHAREHOLDER: I do not suppose the Postmaster-General will acknowledge himself to be defeated.

The CHAIRMAN: We know that we are well within the law, and the Post Office Authorities know that too. We are not endeavouring by any side-wind to attain our object. As the Postmaster-General would not let us unite in the way that was most proper we did what was open to us to do by arranging to unite under the banner of the National Company. What we have done we have done most openly, and I regret to hear the expression side-wind used.

A SHAREHOLDER: I did not say that we had acted by a side-wind, but that the Postmaster-General might say that we were trying to carry out our wishes by a side-wind.

The CHAIRMAN: No doubt.

A SHAREHOLDER: Will he not take some action by litigation?

The CHAIRMAN: Well, we must take the gifts the gods provide.

A SHAREHOLDER: It is well to look things in the face.

The CHAIRMAN: We have done so, and the result of looking things in the face is this proposed amalgamation.

Mr. F. R. LEYLAND: I think I may say this in reply to that, as it is a very material point. The Postmaster-General has an undoubted right to refuse to allow us to transfer our license. That we cannot contest, as it is incontestable; but as each company has a license over the whole United Kingdom he has no power to prevent us from selling our Company to another of the companies that has that license. It is not an evasion at all. It is the exercise of a right that we have, and we have taken very great care by consulting with the best counsel at the bar to see whether we are right in our view, and we are told that there cannot be a shadow of doubt about it—that we are strictly in our right. In fact it has never been insinuated by the Postmaster-General that we are not doing what we have a perfect right to do. He would have stopped us quickly enough if he could.

A SHAREHOLDER: I do not wish to detain the meeting, but I desire merely to say that after looking as carefully as I can at what is proposed I can see no objection which is reasonable that can be taken to the directors' action. As regards the Postmaster-General, I do not think we should be afraid of him. He is not likely to do anything of an oppressive character to us in the future. He is the head of a great department. We are not taking advantage of him in any matter, and are not acting by a side-wind at all. I only now wish to point out one thing which I consider of very great importance—that is, the information which the Chairman has given us as to infringing companies. I forget how many instruments he said had been given up. (The Chairman: 2,000.) He also stated that practically all opposition to the validity of our patents had been finally "squashed." That is the most important piece of information, I think, that he could have given us as to our future.

A SHAREHOLDER: I see that the Directors of the new Company have the power to appoint a Managing Director. A great deal has been said about the Managing Director of this Company, and that he is so much occupied that he cannot attend to our business. I should like to have had a promise from the Board as to what they are going to do in the exercise of that power. I speak to a great extent as a telephone user, and I cordially support this amalgamation, because I think it will be for the benefit of the whole nation—not only for the benefit of the shareholders of the United Company, but I think for the benefit of the whole nation. There is another point also by which I think we shall be benefited—that is, that perhaps the working expenses will be a smaller proportion of the gross receipts. According to the National Telephone Company's accounts—and I suppose we shall have something of the spirit of that Company about the new united Company—their working expenses were about £34,000 against £44,000 of net revenue—that is, their net revenue is about £10,000 more than their expenses. In the case of our Company, I am sorry to say the net revenue is less than the expenditure.

The CHAIRMAN? I did not quite catch what the last speaker said.

The SHAREHOLDER: I think I asked three questions. One was what the Directors will do about the appointment of a Managing Director, and also especially as to his salary, though I forgot to mention that; and further, whether there is likely to be any reduction in the working expenses as compared with the net profit—whether we may in the future look to the profit being considerably more, say 25 per cent. more than the working expenses, or whether it will remain as at present, namely, somewhat less than the working expenses.

The CHAIRMAN: As regards the appointment of a Managing Director, it will be perfectly impossible for me to give any answer to-day. I am here only as Chairman of the United Company, and it will be for the Directors of the new National Company, when you have confirmed these resolutions at your next meeting, to proceed to the appointment of a Managing Director—in fact, of a managing body. I should be very glad to tell you anything I could, but it is impossible to-day. I shall never have the pleasure of meeting you again as Chairman of the United Telephone Company.

A SHAREHOLDER: Yes, once more.

A SHAREHOLDER: We are already the largest shareholders of the National Company, and if we amalgamate we shall still be the largest shareholders in that Company; therefore, any expression of opinion from this meeting ought to have due weight with the Directors of the National Company.

The CHAIRMAN: It shall have due weight, but I cannot answer your question until the new Board meet and decide as to what is to be done. We shall bear in mind what you have said on this and any other points. The same answer must apply to the question about the salary of the Managing Director.

A SHAREHOLDER: It seems to me, as we are settling the new company with Articles of Association for all time, that hardly sufficient attention has been given by the shareholders to the Articles as it is proposed to alter them. It is true that a copy of the proposed alterations has been lying at the offices of our Company, yet I suppose not one-tenth of the shareholders have seen it. Even if they have, it is impossible for them in the space of the few minutes which they could devote to thoroughly digest the alterations. I think, therefore, it is highly desirable that, between now and the special meeting to be convened for passing these three resolutions—[A voice: Confirming them]—these new Articles should be printed and distributed to all the shareholders. We could then come prepared to criticise these alterations. It will settle them for ever, and my suggestion, if acted on, will do away with unpleasantness at future meetings perhaps.

Sir E. H. GALSWORTHY: I think there is a great deal in the observations of the last speaker. At first it would strike one as better—I was going to say fairer, though our Directors could not do anything unfair—had we had a copy of the Articles of Association At the same time, what is proposed is that the Articles of Association shall be those of the new National Company. This is a transfer of this Company to the National Company, and, consequently, you must adopt the Articles of the National Company until you make some alterations in them. Will you tell us whether you are going to adopt the National Company's Articles as they are, or are these Articles, which have been exhibited but which have not been seen, new and fresh?

The CHAIRMAN: They are new and fresh Articles, adapted to the circumstances of the case.

Sir E. GALSWORTHY: Then they are new Articles?

The CHAIRMAN: To a certain extent.

Sir E. GALSWORTHY: Then I think it would have been better had we had a copy of them. Will you, then, please say who are to be the

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Directors under the new Articles, as that bears on the question put by the gentleman who first raised this point.

A SHAREHOLDER: I may say that I applied for a copy of the proposed Articles of Association and was unable to get them.

A SHAREHOLDER: Is there to be any extra remuneration to the Directors?

The CHAIRMAN: No, there is not. The new Directors will be all the present Directors of the United Company, four of the National Company, and four of the Lancashire and Cheshire Company, and their names are: Messrs. Agnew, Batten, Brand, Bruce, Forbes, Peter Garnett, Heyworth, Col. Jackson, Leyland, Morgan, Parrish, Quilter, Robertson, Sands, and Alderman Thompson.

Sir E. GALSWORTHY: That being so, do I understand that the remuneration of the future Board is limited to £5,000, apart from any interest in the profits, and that the new Board will have power to appoint an Executive?

The CHAIRMAN: Yes; here is the article. Shall I read it?

Sir E. GALSWORTHY: I will take your word for it. That being so, I think this meeting might very well leave to the new Board the questions of who they are to appoint as the executive, and what they are to pay them. There can be no question that the new Board will be—well, I was going to say, a very superior Board to the present. I did not mean that in the sense the meeting has taken it, but a larger Board, and as they are to have some excellent people added to their number it must be a better Board. We might therefore leave these matters to them. We must also bear in mind that it is not what these Directors do in the future with respect to the executive, because what they do can be reviewed by the shareholders in the future. It is quite true that under these Articles of Association they have the power to appoint the executive and to pay them what they think fit. What they do, however, must be reasonable; otherwise the shareholders will alter the Articles of Association. I see the solicitor present, and if I am wrong in what I am saying he will put me right; but if I am right in my view, I think we can well leave these matters in the hands of the Board.

A SHAREHOLDER: We hold a large number of shares in subsidiary companies not embraced in this amalgamation. We hold a very large number of shares in the Telephone Company of Ireland, the Western Counties and South Wales Company, and the South of England Company.

The CHAIRMAN: They are all included in the amalgamation at the market price.

The SHAREHOLDER: That means that the United Telephone Company, to whom those shares at present exclusively belong, and which shares are to a great extent undeveloped, hand them over along with our other assets, and that in future the interest in the development of these shares is participated in by the National and the Lancashire and Cheshire Companies with the United Company, who are at present the sole owners of them.

The CHAIRMAN: That is so.

The SHAREHOLDER: I think it is a very good bargain for the National and for the Lancashire and Cheshire Companies.

Mr. LEYLAND: We have heard views quite the reverse.

The CHAIRMAN put the resolution, and it was adopted. Continuing, he said: The next resolution is—

"*That with the view of giving effect to the above-mentioned agreement, and in order to enable the shares to be allotted thereunder to be distributed among the members of this company, this company be wound up voluntarily under the Companies Acts, and that Mr. Thomas Abercrombie Welton be, and he is hereby, appointed liquidator for the purpose of winding up its affairs and distributing its property.*"

The DEPUTY-CHAIRMAN: I beg to second that.

The CHAIRMAN put it and it was carried. He afterwards proposed the following resolution:—

"*That pursuant to the 161st Section of the Companies Act, 1862, the liquidator be, and he is hereby, authorised to carry the said agreement into effect, and to receive the shares agreed to be allotted thereunder and to distribute the same, together with the shares of the National Telephone Company (Limited) already held by this Company, in specie among the members of this Company.*"

The DEPUTY-CHAIRMAN: I beg to second that resolution.

A SHAREHOLDER: I want to ask the meaning of the words "in specie."

The CHAIRMAN: We have had many inquiries on that point, respecting which I have been astonished. It is a legal phrase, not meaning gold and silver, but in kind.

A SHAREHOLDER: In shares of the National Telephone Company?

The CHAIRMAN: In kind. In shares of the National Telephone Company.

The SOLICITOR: The shares will be distributed in shares, and will not be sold and converted into money.

The CHAIRMAN put the motion, and, having declared it carried, said: That is the business of the day.

Sir E. GALSWORTHY: Before this meeting dissolves there is one duty we have to perform, and I think you will agree with me in regarding it as a duty—that is, to express our opinion upon the services of the Directors during the past year. I am one of those who attended the last meeting, and I heard very considerable discussion. I remember that the Directors were taken to task over all sorts of things. I have been watching the telephone companies from that time to this, and it has always seemed to me, as it must to you, that to bring about this arrangement which has been so unanimously adopted to-day must have given an enormous amount of trouble to the Board. In times past we have admired our friend Mr. Brand, and I admire him very much to-day. He is not only an able and useful Director, but a highly ornamental one as well. I mean that as an absolute fact. I am one of those who think that the Directors have had a very nice thing in getting £11,000 in fees for the last year, but that has come to an end, and I do not begrudge the amount. This is a most complicated matter, as any one can see who examines the accounts of the Company. There is one point that I much regret—that is, the statement of the Chairman that this is the last time that he is going to preside over us. I hope, on the contrary, that we shall see him often, for he is a capital Chairman. I now move—

"*That the best thanks be given to the Directors for their able services and great attention to the interests of the Company.*"

A SHAREHOLDER: May I be allowed to second that? The Directors of this Company have not allowed their own interests to stand in the way in this matter. They have given up for the general benefit the emoluments they enjoyed, which this year amounted to £11,000, and content themselves with the much smaller amount of £5,000 a year, and that is between fifteen of them.

The motion was carried unanimously.

The CHAIRMAN: Sir E. Galsworthy and gentlemen, on behalf of my colleagues and myself, I in the usual way beg to return you our very sincere thanks for the honour you have done us. I must say this is a much pleasanter way of moving a vote of thanks than the way it was done last year, at the fag-end of the meeting, after bullyragging and baiting us to the utmost. We receive your expressions of satisfaction with great gratitude. It has been a most difficult time during this last year, and I can assure you that, whether we have been overpaid or not, I do not think we have been this year, for this matter has occupied a great deal of our time every week. It has been a most difficult thing to bring about, and now that it is brought about I think it is to the satisfaction of all parties concerned. As far as I am concerned myself, if I have the pleasure of presiding over this Company again, or over the greater Company, I shall

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always do as much as I can to further your interests. I cannot do more than I have done in the past. I will always endeavour, at any rate, to bring an ornamental presence to the meeting.

The proceedings then terminated.

Lancashire and Cheshire Telephonic Exchange Company (Limited).

Report of the Directors to be presented to the shareholders at the eighth annual ordinary general meeting to be held at the Memorial Hall, Albert-square, Manchester, on Tuesday, the 11th inst., at 11 o'clock.

Revenue.—It will be seen that the accounts only comprise a period of ten months, and the subscriptions and rentals pertaining to that period amount to £80,393. 9s. 5d., as compared with £89,797. 5s. 10d. for the twelve months ended 30th June, 1888. The amount of income carried forward, as representing sums received in advance, for periods extending beyond 30th April, 1889, is £45,569. 10s. 8d.. against £40,377. 3s. 5d. in previous year's balance-sheet.

Dividend.—On the ten months' working the profit is £29,586. 15s. 8d., which, with a credit balance of £1,534. 8s. 4d. remaining from previous account, makes a total of £31,121. 4s. After deducting from this sum interest, bank charges, interest on reserve fund, and the interim dividend paid in March last, there remains a balance of £14,983. 15s. 11d. The Directors now recommend a dividend at the rate of 8½ per cent. per annum for the ten months ended April 30th, 1889, from which will be deducted the dividend already paid in March last (calculated at the rate of 7 per cent. per annum), in respect of the half-year ended December 31st, 1888. This will absorb £13,222. 4s. 6d., and leave a balance of £1,761. 11s. 5d. to carry to the reserve fund.

Progress.—The total number of subscribers on 30th June, 1888, to the various "Exchanges" was 4,103, and of private lines 1,430; this year, at 30th April, the figures were 4,422 and 1,556 respectively.

Notice is also given that the following resolutions will be proposed, which, if passed, will be submitted for confirmation to an extraordinary general meeting as special resolutions:—

(1) "*That the Agreement submitted to this meeting, and expressed to be made between this Company and the National Telephone Company (Limited), for the Amalgamation of the two Companies, by a transfer of the business and property of this Company (with certain exceptions) to the National Telephone Company (Limited), in consideration of shares in that Company be, and the same is, hereby approved.*"

(2) "*That with the view of giving effect to the above-mentioned Agreement, and in order to enable the shares to be allotted thereunder to be distributed among the members of this Company, this Company be wound up voluntarily, under the Companies Acts, and that Thomas Abercrombie Welton be, and he is hereby, appointed liquidator for the purpose of winding up its affairs and distributing its property.*"

(3) "*That pursuant to the 161st section of the Companies' Act, 1862, the liquidator be, and he is hereby, authorised to carry the said Agreement into effect, and to receive the shares agreed to be allotted thereunder, and to distribute the same in specie among the members of this Company.*"

The agreement above referred to, and a print of the Articles of Association, as proposed to be altered, of the National Telephone Company (Limited) may be inspected by members at this Company's office, 38, Faulkner-street, Manchester.

The transfer books of the Company were closed on the the 28th day of May, and will remain closed until the 25th day of June, both days inclusive.

NEW COMPANIES REGISTERED.

THE WOKING ELECTRIC SUPPLY COMPANY (LIMITED).—Registered by Bircham and Co., 46, Parliament-street, S.W., with a capital of £20,000 in £5 shares. Object, the construction of works, machinery and apparatus for lighting streets, &c., by electricity. There shall not be less than three nor more than five directors. The first are H. C. Masterman, E. Stevenson, S. C. Phillips, A. G. Gale and H. S. King. Qualification, £100 stock.

CITY NOTES, &c.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.—Application has been made to the Stock Exchange Committee to appoint a settling day in and to grant a quotation to the provisional certificates of £75,000 Six per Cent. First Mortgage Debentures of this Corporation.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The Directors of this Company on Wednesday declared an interim dividend of 5s. per share, free of income-tax, for the quarter ended March 31 last, and payable on the 24th inst. The books of the Company will be closed from the 17th to the 22nd inst., both days inclusive. The traffic receipts for the week ended 31st May, 1889, amounted to £3,960.

COMPAGNIE CONTINENTALE EDISON.—At a meeting on April 13 last this Company was authorised to increase its capital from 7,000,000fr. (£280,000) to 15,000,000fr. (£600,000), and the prospectus has been recently advertised on the Continent of an issue of 6,000 new shares of 500fr. each, upon which 250fr. is to be paid up. This issue will raise the capital to 10,000,000fr., or £400,000.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of May were £3,500, as compared with £3,337 in the corresponding month of last year. The receipts for the month of February, estimated at £3,200, realised £3,204.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of May, 1889, amounted to £2,040, as compared with £1,800 last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of May, 1889, amounted to £52,704, and to £49,003 in the corresponding period of 1888, or an increase of £3,701.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of May, 1889, were £41,064, as against £40,586 for the same period of 1888.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this Company for the month of May, 1889, amounted to £22,800. From the 1st January to 31st May, 1889, they were £106,800, against, in the corresponding months of 1888 and 1887, £108,400 and £103,520 respectively.

SPANISH NATIONAL SUBMARINE TELEGRAPH COMPANY (LIMITED). The numbers are issued of 72 bonds of £100 each to be paid off on and after June 29, 1889, at the National Bank of Scotland, 37, Nicholas-lane, London, E.C. The bonds are to be left three clear days previously for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended May 31, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,835.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month ended 31st May, 1889, amounted to £6,975.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this Company for the half-month ended May 31, 1889, were £3,078, as compared with £2,978 in the corresponding period last year, showing an increase of £100.

PERSONAL.—Mr. James Staats Forbes has joined the Board of the London Electric Supply Corporation as deputy-chairman.

———Mr. Rankin Kennedy has joined, we understand, the firm of Messrs. Thomas M'Culloch and Sons, at the Vulcan Works, Kilmarnock, whose business will be converted into a limited liability company under the title of Messrs. M'Culloch, Sons and Kennedy (Limited). To their ordinary work of general engineering, as carried on during the past fifty years, the new firm will add that of electrical engineering under the direction of Mr. Kennedy.

———Herr Schuckert, of Nuremberg, &c., announces that his business will for the future be carried on under the title of Schuckert and Co., Kommanditgesellschaft, Nuremberg.

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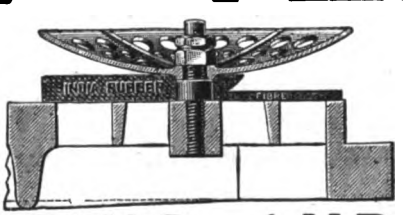

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, June 5, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 5, 1889.	
							Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.			
1,770,360	Stock	12/6	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	53⅞	53
2,614,820	Stock	25/0	Do. Preferred	89 90	4 8 11	,, ,,	90⅜	88½
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	19⅛	19
130,000	£10	3/0	Brazilian Submarine	13¾ 14	5 0 0	Mar., June, Oct., Dec.	14	13⅞
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	103	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14⅞	14½
6,000	10	10/0	Do. Preference 10%	19 20	5 0 0	,, ,,	19⅛	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4¼	4 4 8	March & September	...	...
6,000	5	5/0	Do. Preference 10%	8½ 9½	5 5 3	April and October	...	...
60,710	20	3/6	Direct United States	10½ 11	5 0 0	Jan., Apr., July, Oct.	10⅞	10⅝
330,000	10	2/6	Eastern	13⅛ 13⅜	4 9 9	,, ,,	13⅜	13⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅞ 15¼	3 18 8	,, ,,	15 3/16	14⅝
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109½	108½
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	109	...
250,000	10	5/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13⅜
329,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	104⅞	103½
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	105¼	104
179,177	10	3/0	Globe Telegraph and Trust	8 8¼	5 0 0	Jan., Apr., July, Oct.	8¼	8
178,992	10	3/0	Do. 6 per Cent Preference	14⅜ 15	4 0 0	,, ,,	15	14 13/16
150,000	10	5/0	Great Northern	15½ 16	4 13 9	Jan., July, and April	16¼	15
17,000	25	2/6	Indo-European	39 41	6 1 11	April and October	40½	40
9,000	8	8/0	Reuter's	7 7½	5 6 8	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	..	...
30,000	10	6/0	West Coast of America	10 10½	5 14 3	January and July	10⅜	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2½ 2⅝	...	...	2 1/16	2⅛
34,563	10	12/0*	Do. 1st Preference 6%	11¾ 12¼	...	April and October	12¼	11¾
4,669	10	†	Do. 6 per Cent. 2nd Preference	14 15	...	...	14⅝	...
45,181	15	6/0	Western Brazilian	12½ 13	5 15 7	March & September	12⅞	12⅝
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	4½d.	Consolidated Telephone and Maintenance	1 3/16 1 5/16	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	15/16 1 1/16	3 15 8	...	...	...
80,000	5	5/0	United	15⅛ 16	5 9 5	June and December	16 5/16	15¾
55,000	5	3/0	United River Plate	6⅜ 6⅝	...	January and July	6½	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3¾ 4¼	...	...	3 13/16	3⅝
23,692	5	2/0	Do. (fully paid)	4½ 5	...	February & August	5	4¾
79,934	5	...	Swan United (£3. 10s. paid)	3¼ 3½	...	...	3⅜	3
312,000	½	...	Maxim-Weston	4⅛ 4⅜	...	February	...	...
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	41 43	5 11 9	March and July	42⅜	41⅜
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19⅜	19⅛

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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NOTES.

A communication from Lord Rayleigh and Sir William Thomson in another column raises a note of warning to electrical engineers not too hastily to incur the risk of perpetuating confusion in the terminology of alternating currents. Brevity is good, but lucid and accurate phraseology is better, and our readers will probably concur with the recommendation, for the present at least, to speak always of *period frequency*. Had it not been for the evil example of the French Academy, the practice of dealing with less than a complete vibration would long since have fallen into entire disrepute. But so long as any possibility of misconception remains we must be prepared to make the necessary sacrifice of brevity.

In our report of the meeting of the Physical Society, held on Saturday last, will be found a transcript of a somewhat remarkable lightning photograph, which was obtained by Dr. Hoffert during the great storm of the previous Thursday. It may be taken to confirm the impression, which probably most observers shared, that several successive discharges sometimes followed in the same track at extremely short intervals. Whilst watching this storm from an open heath in the extreme South-West of London, we noticed several flashes which appeared like tangled skeins of flossy silk, the colour being a beautiful red. The red colour was, perhaps, due to the London atmosphere, as all flashes of this colour seemed to be far off in the N.E., whilst the nearer flashes were white or bluish. We may add that Dr. Hoffert tells us that the photograph was taken with a small quarter-plate camera, on an Ilford rapid plate—either the "new" or the "special" plate, it is not quite certain which. The camera was being moved by hand about once to and fro in three-quarter seconds as nearly as could be judged.

We learn that during one of the recent storms a lamp-post at Hampstead was struck, and a side flash, spitting off the horizontal bar with which lamp-posts are usually provided, knocked several bricks out of an adjacent wall. Query—if the owner of the wall could prove that the post was *not well earthed*, would he have his remedy at law? In another case some wooden telegraph-posts are reported to have been demolished. Here, of course, the earth may easily have been bad, but it would be interesting and probably instructive if Mr. Preece would tell us what happened to the wires.

Mr. E. W. Smith's singular device, which Prof. Ayrton has christened by the name of the Shunt Transformer, caused much interest at the Physical on Saturday. The arrangement is so simple that it will be understood at a glance on referring to the diagram on another page. The theory is, of course, a little more complex, but everything depends upon the fact that when an alternating current is divided betwixt two branches, one of high resistance and of small inductance, and the other of high inductance and small resistance, the current phases suffer a relative displacement which in the limit approaches 90 degrees. One result which Mr. Smith succeeded in proving experimentally is that under certain conditions the reading of a dynamometer in the main circuit may *diminish* whilst the lamps actually *increase* in brightness. As Prof. Silvanus Thompson remarked, this sort of thing tends to prove the hollowness of the idea that alternate-current meters can properly be based upon the measurement of coulombs.

Prof. Silvanus Thompson read a Paper at the same meeting, cataloguing eight different methods of suppressing the spark in breaking the circuit of an electro-magnet. Of these the most novel and curious is due to Mr. Langdon-Davies, of Phonopore fame, and consists in winding the magnet with layers of fine wire connected in parallel arc. The resistance and hence the time-constant in the different layers being unequal, at the moment when in one layer the E.M.F. of self-induction is, or would otherwise be, high enough for sparking, it finds a path for discharge along another layer whose time constant is greater. Prof. Thompson spoke only of the application of this principle to magnets of Telegraphic dimensions, but it would seem possible by specially arranging circuits with different time-constants and different current-carrying capacity to extend it to magnets of any size.

We are pleased to be able to announce that Lord Salisbury has consented to receive a deputation on Wednesday next, June 19th, with reference to the proposed Electrical Standardising Laboratory. The deputation will consist of the Earl of Crawford, Lord Rayleigh, Sir William Thomson, and Sir John Lubbock (as Chairman of the London Chamber of Commerce).

The Board of Trade Inquiry held at Dublin last week possessed some very singular features. In this case the Gas

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Company maintains that by virtue of their Private Act of 1866 they are empowered both to supply electric light and to take up the streets for the purpose of laying mains, and that they therefore require neither Order nor License. It will, perhaps, be remembered that a similar claim set up on behalf of the Liverpool Gas Company in 1883 or 1884 was allowed by the Board of Trade. It was of course admitted that by the Electric Lighting Act of 1883 it was necessary to obtain the sanction of the Board before proceeding to make use of these privileges. Major MARINDIN remarked that he need not concern himself about the precise extent of their existing powers, but that it was his duty to report to the Board of Trade as to the advisability of their being permitted to exercise such powers supposing they did possess them. The Company presented a scheme which contemplated the use of motor generators and secondary batteries for the supply of 2,500 lamps, the capital cost being estimated at from £13,000 to £16,000. Unfortunately, the technical details are not at present before us. Prof. FORBES pronounced the scheme, on the whole, admirable. The Corporation objected *in toto* to the assumptions made by the Gas Company, and is anxious to have its existing powers as to street lighting extended so that it may undertake the supply of electricity for private purposes throughout the City, for which purpose it is proposed to employ the water-power of the Liffey at Islandbridge. The Gas Company had nearly exhausted their present powers of raising capital, whilst the Corporation could borrow to an unlimited extent. To Mr. E. MANVILLE was entrusted the task of exposing the weak points in the scheme of the Gas Company. The Inquiry was over early on the second day.

WE are glad to see that Mr. MASSINGHAM has now publicly announced his intention of proceeding with the Bath Central Lighting Station, in spite of the failure of the public to subscribe the capital for the proposed Limited Liability Company. Mr. MASSINGHAM has secured a magnificent site, almost in the centre of the city, with ample water-power for present purposes and abundant room for future extension, and we have not the slightest doubt that he will carry the venture through to a successful issue.

ALTHOUGH every fifth-rate town in the United States has its complete system of street police signals; here in London the system has only recently been introduced, and that only in a tentative manner and in a single district. We are happy, however, to learn that the authorities have been very favourably impressed with the performance of the system in Islington, where it has now been at work for some six months. Although Islington is not, we believe, one of the most turbulent quarters of the town, yet the signals have already rendered noteworthy service in the arrest of burglars and in summoning aid to secure violent prisoners. It is even said that the knowledge that additional assistance is always within call has already operated to check the tendency to commit assaults upon the police when engaged in the discharge of their duty—a tendency which certain evening papers have done so much to foster. Not the least of the services which such a system is called upon to render is in providing means for the rapid conveyance of injured persons to the hospital. In at least two cases it is believed that the promptitude of the succour thus obtained has been the means of saving life. We shall hope to see the system speedily extended to all parts of the town.

IN reference to the proposed Telephone Convention, we printed in our issue of May 24th (p. 55) a circular which had been issued by Dr. J. MAIER, in which it was stated that the Convention "has been organised by the representatives of the Telephone Companies and the Post Office." The wording of the circular was therefore calculated to lead to the impression that the Convention was in some sense under the official sanction of the Postal Telegraph Department. This, however, is not the case; Mr. W. H. PREECE, although a member of the Committee, is acting solely in his private capacity.

OUR readers will be gratified to learn that the Lords of the Admiralty have consented to exhibit at the forthcoming Electrical Exhibition at Bingley Hall an extensive series of electrical appliances in use in the Navy. The exhibit will include Whitehead torpedoes—in whole and in section—submarine mines, detonators and firing apparatus, submarine lamps and telephones, electric gun-firing appliances, &c. This display cannot fail to add greatly to the interest of the Exhibition. Another object of special interest will be the very early magneto machine built in 1841 by Mr. WOOLRICH at the works of Messrs. PRIME and SON at Birmingham. This machine was long used for electro-plating work, and is without doubt the first electromagnetic machine regularly employed for industrial purposes. An interesting collection of electric-lighting apparatus, including a very early incandescent lamp, is being sent over by Dr. WOODWARD, of Toronto. The contract for erecting the boilers, engines, and other foundations, the orchestra, and the general work connected with transforming Bingley Hall into a fitting home for the Exhibition, has been entrusted to Mr. JOHN PARKES, and the works will be pushed forward with all possible despatch. It is intended to open the Exhibition on Thursday, the 1st of August.

WITH regard to the exhibit from Toronto, of which mention is made above, if all we hear be true the name of Dr. WOODWARD is likely before long to assume some degree of prominence in electrical circles. We have ourselves seen a specification, dated well back in the seventies, in which the learned doctor would appear to have anticipated at least one, possibly two, inventions of the very first importance, and one of which has already been the subject of prolonged litigation. Our readers will naturally be curious to learn how it comes to pass that an inventor of such distinction has "lain low" all these years. Thereby hangs a tale; but for the present we can only reveal the fact that Birmingham may claim the proud distinction of being reckoned the birthplace of this distinguished man; hence there is a certain dramatic fitness in the idea that at Birmingham his achievements should first be brought to the light of day. But of this more anon.

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Llandudno.—Llandudno pier and pavilion were lighted with the electric light for the first time on Saturday evening.

British Guiana.—The cable between Trinidad and Demerara, which broke down about a fortnight since, is now repaired.

Lowestoft.—The Electric Light Supply Company of Lowestoft have given notice to the Town Council that they intend applying for a Provisional Order.

The West Coast of Africa Cables.—We learn that telegraphic communication has now been extended to Benguela and Mossamedes, on the West Coast of Africa.

The New Telephone Company.—In connection with the above we would direct the attention of those interested to an advertisement which appears in another column of this issue.

Electrical Execution.—A motion has been brought before the Municipal Council of Paris for the adoption of execution by electricity. The matter has been referred to a special committee.

Messrs. Crompton and Co.'s Annual Dinner.—On Friday evening, the 31st ult., the annual dinner of this company to the present and past pupils of the firm was given at the Café Royal, Regent-street. The bill of fare was excellent in every respect, and the arrangements both as regards toasts and music gave much satisfaction and entertainment to the guests, who separated about midnight after spending a most enjoyable evening. The invitations included a goodly number of friends prominently connected with electrical industry and its representatives in the press.

Patents, Designs, and Trade Marks Act.—For the purpose of giving effect to the provisions of the Patents, Designs, and Trade Marks Act, 1888, relating to the registration of patent agents, the Board of Trade, by virtue of the said Act, have issued a set of rules, 23 in number. These rules determine, *inter alia*, the register to be kept and its contents, the registration of persons who were patent agents prior to the passing of the Act, the final qualifying examination for registration, exemptions of pupils, inquiry by Board of Trade before erasure of name from register, and directions as to the hearing of appeals.

Visual Reproduction of Alternate-Current Waves.—Messrs. Siemens and Halske, says the *Bulletin de l'Electricité*, employ the following apparatus for rendering the current phases visible :—A beam of light, which passes through a lens and a small circular opening, is directed on to a mirror fixed to a telephone diaphragm. The beam is reflected on to a revolving polygonal mirror, and thence on to a screen, upon which it describes the current curves on a magnified scale. The forms of current curves of alternating machines are obtained by inserting a telephone as a shunt on the circuit. It will be remembered that Prof. Ayrton recently described a very similar device before the Electrical Engineers.

The Proposed Electric Lighting Company at Bath.—Mr. Massingham has addressed the following letter to the editor of the *Bath Herald*:—

"Sir : From the enthusiasm the electric light aroused in our city, the almost unanimous decision of the Council to adopt it in our streets, and the large number of applications I received from citizens anxious to be supplied with it, I had supposed there was no doubt the Bath Electric Light Company (Limited) would have met with generous support, but, owing to the successful tactics of interested persons, the reverse is the case, and the directors at a recent meeting decided not to adopt the contracts provisionally entered into on behalf of the company. A responsibility therefore attaches to me which I should gladly have shared with my fellow citizens. But, undaunted by the above result, I readily accept the position, and have no hesitation in undertaking single-handed to light an important city like Bath, having not an atom of doubt that as I succeeded at Taunton so shall I succeed here. I intend shortly to lay down plant for public and private lighting, and shall be prepared not only to carry out the contract I have entered into with the Council for lighting the principal streets, but also to supply all private consumers (in the area contracted for) at a price at which the electric light has never hitherto been supplied in any city in the world.

"Bath, June 7, 1889." "H. G. Massingham.

Obituary.—We regret to learn that Mr. John Frederick La Trobe Bateman, F.R.S., V.P.R.C.E., died on Monday morning at Moor Park, Farnham, at the age of 79, after an illness of ten days. He had acquired a high reputation for his scientific attainments, his name having been associated with several of the principal engineering achievements of the day. He supplied Glasgow with water from Loch Katrine, and proposed a scheme to furnish London with water from Lake Bala in Wales. At the time of his death he was engaged in engineering work in connection with docks and gas at Buenos Ayres and water service at Minorca.

Thunderstorms.—On Thursday, the 6th inst., severe thunderstorms occurred in many districts, especially those lying to the South of London. At Bermondsey the tower of the old parish church was struck, and a portion of the plaster ripped off. The chancel of St. Mark's Church, Coburg-road, S.E., was set on fire by what was described by an eye-witness as a ball of fire with a zigzag tail. The roof of St. Giles, Camberwell, was struck, and the Holmsdale Arms, Thornton Heath, was set on fire and partially destroyed. At Partridge Green, a group of farm buildings, known as Broke Wood, was set on fire and almost completely destroyed. Several trees were struck near Denn's Park, and in the Brighton road the tiles on the roof of a workshop were split, the same flash severing a 10-inch beam. The telegraph wire between Horsham and Slinford was cut through. A storm broke with great violence over Steyning ; at Pulborough the iron step of a carriage was cut in two by a flash of lightning. In High-street, New Shoreham, a chimney was split from top to bottom, the bricks falling through the roof of a neighbouring house and doing considerable damage. At Worthing three houses were struck. At Petworth three telegraph poles were struck, one of them being split to pieces. At Stebbing a house was set on fire and a chaff-cutting machine twisted in an extraordinary way. Damage is also reported from Cambridge and the neighbourhood. At Tydd, near Wisbech, a house was struck and burnt to the ground, the same flash killing three horses. The hailstones in many parts of the country were of exceptional size ; at Ipswich they broke the ribbed glass of the Corn Hall, which is over an inch in thickness.

Notes on one of the Recent Thunderstorms.—Prof. Oliver Lodge sends us the following interesting notes on a thunderstorm which occurred in the neighbourhood of Liverpool on the 1st inst. The observations were made by Mr. J. K. Montgomery, a student at University College, Liverpool, and are embodied in a letter to Prof. Lodge :—

"There has just occurred a heavy thunderstorm, and perhaps my unscientific observations of it may to some slight degree be interesting to you. About 3:30 I began to hear the thunder in the distance, so I determined to go out for purposes of "observation." There was not a drop of rain nor a breath of wind, and the air was fearfully hot and close. By this time the thunder was perfectly continuous, though not violent, the dull rumblings being broken by occasional louder bursts. I suppose really it was a series of crashes, but that is the way it presented itself to my mind. I went to the top of Woolton Hill, as that was the most open place about, though perhaps the most dangerous. As soon as I began to get more into the open I saw the flashes, some of them most gloriously beautiful, and curious into the bargain. One of them seemed to describe an irregular arc of a circle, then almost retrace its course, and then flash four or five times right across the sky. In almost all of them I could count four or five times that they crossed the sky backwards and forwards. One or two came almost perfectly straight down, and appeared to strike the road a few yards away from me. I noticed that the perpendicular flashes always seemed single flashes instead of the flash and reflash of the horizontal ones. The thunder was now right overhead, the lightning being seen at intervals of a few seconds. The clouds seemed of a deep grey colour, with broad light copper-coloured edges. Hitherto there had been no rain or wind, but now a sudden gust swept along the road, followed almost immediately by a furious shower of rain. It was not only rain ; there were great blocks of ice, mostly about the size of marbles. I examined them, and observed that they were pretty clear at the edge, but the middle was white and almost opaque. I picked up one block of ice, which was almost quite clear, and about an inch and a-half long by three-quarters of an inch broad and a third of an inch thick. It was of very irregular shape, unlike the rest, which were nearly spherical."

Reception of and Dinner to Prof. Elihu Thomson.—Among the many men of eminent scientific ability and attainments now visiting this country from the United States, one of the most distinguished must be considered to be Prof. Elihu Thom-

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son, President of the American Institute of Electrical Engineers, member of many other learned societies, and the moving spirit of the Thomson-Houston Electric Company. The close affinity of the Laing, Wharton and Down Construction Syndicate with the Thomson-Houston Company (its *raison d'être* being the extension of the Thomson-Houston system of lighting) rendered it natural that they should seek to welcome the Professor on his arrival in England, and this welcome took the form of a reception and dinner on Wednesday evening last, at the Ship Hotel, Greenwich. Colonel Martindale C.B., late R.E., Chairman of the Finance Committee of the Syndicate, occupied the chair, and was supported by Mr. Percy Westmacott, Dr. Merz, and Mr. Crewdson, Members of the Committee, and by Messrs. Wharton, Down and Davies, the Syndicate's Expert Managers, and Mr. Warine Martindale, the Secretary. Among the guests met to do honour to the Professor were—Sir William Thomson, F.R.S.; Sir Frederick Abel, C.B.; Profs. George Forbes, John Perry, Silvanus Thompson, Ayrton and Hughes; Captains Candee and Holden; Dr. J. A. Fleming; Messrs. J. T. Moulton, Q.C., M.P.; R. W, Wallace, J. T. Bottomley, W. Lant Carpenter, Killingworth Hedges, Musgrave Heaphy, H. G. Massingham, J. F. Meech, W. Lake, C. W. Price, C. E. Spagnioletti, J. W. Swan, W. H. Snell, J. B. Verity, J. E. Wright, &c., &c. Some others of our leading electricians were unable to accept the Syndicate's invitation. The Professor was received on his arrival by a few words of welcome from the Chairman, who was followed by Sir Wm. Thomson, Sir F. Abel, and Mr. Swan. After a brief reply from the Professor the company proceeded to dinner, to which about 46 sat down. The toasts proposed by the Chairman were "The Queen," "The President of the United States," "Professor Elihu Thomson." "Prosperity to the Thomson-Houston System" was given by Dr. Merz, and "Our Guests" by Mr. Wharton. The Professor returned thanks; Mr. Meech, of the Thomson-Houston Company, replied on their behalf, and Mr. Moulton, Q.C., for the guests. The reception and dinner may be taken as an honour justly due to Prof. Elihu Thomson, and as constituting another link in the chain of friendship which is binding ever closer together individuals in the two countries, and thus the two countries themselves.

The Lighting of Reading.—At the meeting of the Reading Town Council on Thursday last week the question of the electric lighting of the streets came up for decision. The report of the Sub-Committee appointed on the 5th ult. stated that they had given consideration to the whole subject of the lighting of the town in view of the termination on June 30 next of the existing contract with the Reading Gas Company; and that they had conferred with the Gas Company and with Messrs. Laing, Wharton and Down, electrical engineers, who are supplying electricity for lighting purposes in Reading. The Gas Company had announced their intention to reduce the price of gas 3d. per 1,000 cubic feet to all consumers, and in any future arrangement with the Company for public lighting the Council would have the benefit of this reduction. The Sub-Committee had also received a proposal for lighting the principal parts of the town by electricity from Messrs. Laing, Wharton and Down, who suggested that the wires for the purpose should be carried overhead, and that the lamp-posts and supports should be supplied by the town. The cost of the gas consumed in the lamps displaced by 30 arc-lamps properly disposed in the places intended to be lighted, they calculated at £455. With respect to the cost of the electric light, they said they were prepared to supply on the following terms, the lamps to be alight for 3,900 hours per annum:—£25 per lamp per annum on a five years' contract, or £24 per lamp per annum on a seven years' contract. Taking £25 as the basis of the cost of the electric light, with 30 lamps, the cost would be £750, against £455 the present estimated cost of the gas; but "ten times the light is given." In other words the cost per candle-power per annum was:—Electric light, 5d.; gas, 41d. The Committee did not make any recommendations in regard to the matter, and the report was adopted. Mr. Field then brought forward a resolution to authorise the sub-committee of the Highways, Streets, and Gas Committee to arrange the terms of a contract with the gas company for the lighting of the public streets upon a specified basis, in which provision was made for the discontinuance of the gas lamps during the whole or any part of the night within any area which the Council might determine to light by means of electricity. The resolution was approved. Mr. Dodd next proposed—"That it is advisable that arrangements should be made, as soon as practicable, for lighting by electricity throughout the whole night such a district as it may be possible to light satisfactorily with 30 electric lamps, and that the Highways, Streets, and Public Lights and Gas Committee be authorised, subject to the approval of the Council, to arrange with Messrs. Laing, Wharton and Down, the electrical engineers, accordingly." He remarked that he had formed the opinion that the electric light recently shown in the town was very desirable indeed for public lighting, and the sooner they took into consideration the lighting of the town by this means the better. The motion having been seconded, the question was fully debated, and, in the end, the resolution was carried by 14 votes to 9.

Electric Launches on the River.—We take the following from a recent article in the *Daily News*:—"Talking of steam launches, their day is undoubtedly fast drawing to an end, so far at least as the upper Thames is concerned. If any one doubts this he has only to go and inspect the 'Ray Mead,' lying out in front of the Ray Mead Hotel, just above Maidenhead. She is not yet certified by the Board of Trade. Her owner duly applied for a certificate, and received the usual form to be filled up, giving full particulars of her engines and boilers, and the names of those who made them, what pressure they were designed for, and so forth. The only reply that could be given was that there were no engines and no boilers on board, and though some little time has elapsed since this answer was transmitted nothing further has been heard of the matter. Who can say what putting together of heads and grave deliberation this knotty point may not have given rise to in Whitehall? How to certify a vessel the boilers of which might possibly blow up in spite of the best precautions would be easy; but how to certify when there are no boilers at all may, no doubt, form a very moot point for the Circumlocution Office. However, no doubt it will be settled one of these days, and the 'Ray Mead' will be free to take on board her 60 passengers and set out on her travels. She is an absolutely ideal craft for the Thames. She is built of Burmese teak; she is 60ft. long and 11ft. in the beam; is daintily fitted up with the electric light, and stained glass and brass fittings, and yellow curtains that harmonise very prettily with the rich brown of her timber. All her motive-power is stowed away under the floor of the cabin, and the switches and the rudder-wheel by which she is navigated are under the hand of one man up over the cabin. Messrs. Immisch and Co. have supplied the motors, and they claim that she will run for twenty hours on the stream at seven miles an hour, which is the maximum allowed by the Conservancy regulations, and she can be fully charged in four hours and a-half, which, of course, may be done during the night. The difficulty in the way of electric launches on the Thames hitherto has been this matter of charging among others. This is now disposed of. Messrs. Immisch and Co. have established charging stations at Richmond, Hampton, Staines, Maidenhead, Henley, Reading, Wallingford, and Oxford; and they have, besides these, two self-propelling stations ready to move to any point on the river at which there may be special need for them. Ten thousand pounds, it is said, has been laid out in this electric-charging scheme for the Thames, and one result is that four electric launches are now afloat on the upper river, and all hands are at the pump to get five more completed to be ready for Henley. These are in addition to the 'Ray Mead' just described, which is certainly the most beautiful little craft of the kind ever yet constructed. It is said that with all her heavy accumulators, and 60 people on board, she draws only two feet of water, and owing to her small propeller—necessarily small in order to get the best possible work out of her motor—and her excellent lines she makes no more wash than a randan. Electric boats were barely represented last year at Henley; this year it is expected that there will be about a dozen launches. This affords rather a striking indication of the rapidity with which the motive-power of electricity is finding practical application.'

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THE FUNCTION OF THE CONDENSER IN AN INDUCTION COIL.

BY DR. OLIVER LODGE.

Doubtless many persons have written out a theory of the coil condenser at some time or other, either for their own edification or for that of their students, without regarding it as worth publishing.

Since the subject seems to be of interest just now, I may transcribe my working of the case, though I do not suppose it differs essentially from that of Mr. Boys, nor do I see that his differs very essentially from Dr. Fleming's. Nothing can be clearer than Mr. Boys' letter. Dr. Fleming's article is perhaps rather less simple, partly because he has treated the case of a closed secondary circuit.

The whole object of the break is to stop the primary current as rapidly as possible. If M is the coefficient of mutual induction between primary and secondary, and if x is the current at any instant in the primary, the E.M.F. developed in the secondary, while its terminals are too far separated to give a spark, is $M\frac{dx}{dt}$. This quantity, therefore, determines the maximum length of spark attainable. If the secondary circuit is closed the self-induction of the secondary and the reaction of its current on the primary must be taken into account (the effective self-induction of the primary being reduced from L to $L-\frac{M^2}{N}$), while, if it is only partially closed, so as to permit a spark across an air gap, the conditions are too complicated to treat with complete accuracy, because of the varying resistance of the spark.

The case of a quite closed secondary offers no special difficulty, but it is an unusual case in practice, except when the primary current is supplied by an alternating machine; in which case there is no break, and no condenser is of any use. I will consider, therefore, only the case when the secondary terminals are pulled far apart so as to get the longest possible spark.

Breaking the primary circuit consists in separating two metal contacts so as to introduce an insulating film or partition. The air film so introduced is easily broken by the electro-magnetic momentum, and the current, therefore, prolongs itself, and stops more or less gradually, even though the contact pieces are knocked asunder with a hammer.

Much depends, however, on the way the break is made; anything of the nature of a scrape or drag is bad. Perpendicular separation of hard surfaces is best, and if they are separated by the impact of a bullet considerable suddenness may be attained. Still better if the insulating partition instead of being air i alcohol, or some stronger dielectric not so easily burst as an air film. This, I expect, is the main advantage of mercury breaks, viz., that the surfaces are immersed in alcohol. If the alcohol were put under great pressure, so as to be driven between the contact-breaker terminals more quickly than by merely atmospheric pressure, still further improvement might be possible.

But the most sudden way of stopping a current by direct separation of contact pieces, is to effect the break between the poles of a powerful magnet. The extra current then gets blown out with a bang, and the thereby-induced secondary flash is often of surprising length without the use of any condenser at all.

None of these ways can, however, really stop the current quite suddenly, any more than a stream of water can be stopped quite suddenly by the sudden closing of a tap. Moreover, any attempt at sudden stoppage must be accompanied with violence. But, if an elastic piston or recoil spring is provided, the energy of the current instead of being rapidly dissipated may be stored, and the stored energy may be used to propel it backward immediately afterwards. It is like the difference between stopping a truck by a brake and stopping it by fixed elastic buffers. Suitable spring buffers may be capable of causing a greater acceleration at some part of the recoil than any brake which could be applied, and it may act with less violence.

A condenser is the electric analogue of the spring buffer; it receives the momentum of the electric currents, stores it, and under favourable circumstances gives it back—not only stopping but reversing the current.

If it succeeds in checking the primary spark altogether, the current will be reversed, and re-reversed several times; but this seldom if ever happens. A very large condenser seems to be necessary to permit the current to flow unimpeded until the break pieces get quite beyond striking distance; and such a condenser, being analogous to a long weak spring, would not give a very effective recoil. It seems better to use a moderate-sized condenser, *i.e.*, a stiffish spring, so as to enable the contact pieces to separate by an appreciable interval, and to dissipate the rest of the current energy by the obstruction of the by-that-time introduced insulating layer.

The more rapidly the contact pieces are mechanically separated, the less capacity of condenser is necessary.

The ideal arrangement would be to use a very small condenser and to separate the parts with great rapidity.

It may also be remarked that small self-induction in the primary is an advantage, as diminishing the spark at break. Instead of a great number of turns and a battery of high E.M.F., it is far better to use a stout thick primary of few turns, and to send a powerful current through it by a large storage battery of low E.M.F. Since closing the secondary *reduces* the virtual self-induction of the primary, it follows that if a satisfactory break can be made with secondary circuit open, it will be still easier when secondary sparks are permitted.

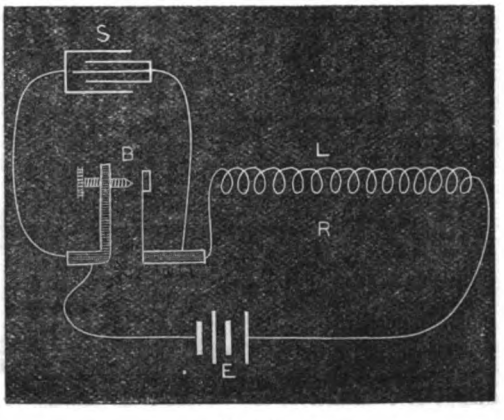

FIG. 1

The investigation of what happens in the primary when the secondary circuit is open is simple enough, and is as follows:—

Let a current, x, be flowing in primary, consider what happens when break occurs at B. The initial condition is, condenser uncharged, and $x=\frac{E}{R}$. Directly the break occurs the condenser begins to charge and the primary to stop. The final condition is, $x=0$, and condenser charged with quantity

$$Q=\int_0^\infty x\,dt=ES.$$

Now the equation to the current during the change from initial to final condition, provided no spark is permitted at B, is given by

$$E-Rx-L\frac{dx}{dt}=\frac{1}{S}\int_0^t x\,dt,$$

which, taking into account initial and final conditions, is equivalent to

$$x=\frac{E}{R}\,e^{-m}\left(\cos n\,t+\frac{m}{n}\sin n\,t\right),$$

where $$m=\frac{R}{2L}\text{ and }n^2=\frac{1}{LS}-m^2.$$

The E.M.F. excited in the secondary at any instant is

$$-M\frac{dx}{dt}=\frac{ME}{RnLS}\,e^{-m}\sin n\,t.$$

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This begins with the value 0, showing that at the first instant after break the primary flows on with undiminished strength, charging the condenser, and thus affording time for the break to get fairly thorough, so as to avoid a spark more or less completely. It has its greatest value at a time T after break, such that

$$\tan n\,T = \frac{n}{m}.$$

It will be convenient to call the angle whose tangent is $\frac{n}{m}$, θ;

so that

$$T = \frac{\theta}{n}.$$

The angle θ is in most cases approximately a right angle unless S is very big.

The maximum value of the E.M.F. thus induced is obtained by inserting this value instead of t, which gives

$$-M\left(\frac{dx}{dt}\right)_{max} = \frac{ME}{R\sqrt{(LS)}}\,e^{-\frac{m\theta}{n}}.$$

Now, if it were possible for n to be negative, the above expression could be given a maximum value by satisfying the condition

$$\tan^2\theta = \frac{\tan\theta - \theta}{\tan\theta + \theta},$$

the solution of which is $\theta = 111^\circ\ 1'\ 52''$,

or

$$\frac{n}{m} = -2{\cdot}6024.$$

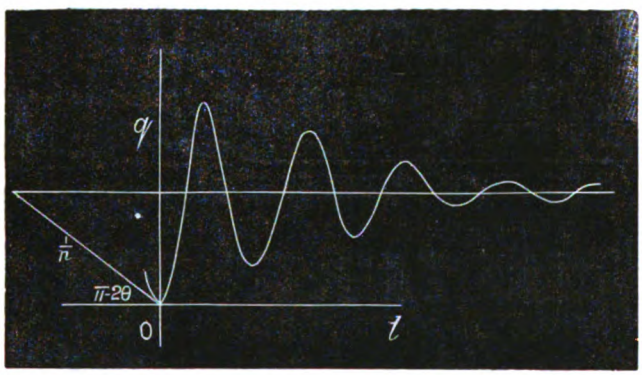

FIG. 2.--Charge of condenser at any instant if no primary or secondary spark occurs.

But as this is physically impossible, the next best thing is for n to be very big—that is, for S and L to be as small as convenient.

L cannot, indeed, be very small, because one factor of it is involved in M; but inasmuch as $\frac{M}{L} = \frac{N\,N'}{N^2} = \frac{N'}{N}$ approximately (the N referring to number of turns of wire), it is manifestly well to have the secondary with the greatest possible number of turns and the primary with very few.

As to S, the capacity of the condenser, it should be as small as is consistent with a stoppage of the break spark; or since it is perhaps not advisable to stop the spark altogether, some kind of compromise must be arrived at, which cannot be gone into much further without specific information as to the rate of separation of the contact pieces.

This much, however, may be said: the difference of potential between the contact-breaker terminals at any instant is proportional to the charge by that time accumulated in the condenser, being equal to $\frac{q}{S}$, where

$$q = \int_0 x\,dt = \frac{1}{n}\left\{\sin 2\theta - e^{-mt}\sin(2\theta + nt)\right\},$$

θ having the same meaning as before, viz., the angle whose tangent is $\frac{n}{m}$.

Fig. 2 is a curve with the general characteristics of this diagram.

If a spark at break is to be avoided, the parts must separate faster than this rapid rise of potential can, so to speak, catch them up, by becoming strong enough to burst the air film they have succeeded in interposing in its way. The charge of the condenser reaches its maximum in a time $\frac{\pi - \theta}{n}$, or practically in a time $\frac{1}{2}\pi\sqrt{(LS)}$. If the terminals can get beyond striking distance within this time they are safe, and there can be no primary spark. But this time is terribly short. For instance, with a condenser $\frac{1}{20}$ microfarad capacity and a primary coil of $\frac{1}{50}$ secohm self-induction, this time is the twenty-thousandth part of a second. Self-induction between break and condenser is wholly bad; the condenser should be connected up as directly as possible.

REVIEWS.

Popular Lectures and Addresses. By Sir WILLIAM THOMSON. In three volumes—Vol. I., "Constitution of Matter." (Macmillan and Co., 1889.)

It appears from the preface that the collecting together in a convenient and accessible form of Sir W. Thomson's Popular Lectures is due in the first place to a suggestion from Mr. Lockyer that the lecture on "Capillarity," which first appeared in the pages of *Nature*, should be re-issued as a separate volume, with the addition of some other matter connected with the subject. Fortunately for the wide circle of readers who will, we trust, make acquaintance with the pages of this charming book, Sir William decided to extend the scope of the work proposed by Mr. Lockyer by issuing a short series of volumes containing such of his more important lectures and addresses as would not find a fitting place in the reprint of his mathematical and physical papers, and they will feel themselves considerably indebted to Mr. Lockyer for his share in procuring for them a great intellectual treat, or rather a series of intellectual treats, for, taking the present volume alone, the Bill of Fare provided is not one which can be assimilated at a single sitting.

Sir W. Thomson's mathematical papers have a charm for those who are able to follow him in his explorations into some of the most obscure and intricate of Nature's pathways, guided by the bright but somewhat overpowering light of mathematical analysis. Sir William's purely scientific work, whether mathematical or experimental, excites our admiration by its massive power; and this applies more especially to the former division of his work, for, while his analysis is often somewhat lacking in elegance and polish, it always goes straight to the heart of a difficulty, and, instead of skilfully avoiding or circumventing it, sweeps it by main force out of the path and exposes the hidden treasures which lay beneath the apparently unsurmountable obstacle. Even in his popular lectures the same sense of power is present with us. Instead of feeling ourselves skimming lightly over the surface of the great sea of scientific knowledge, and obtaining, without much effort on our part, faint and transient glimpses of a distant scene, we feel ourselves led forward by the strong helping hand of a skilled guide over some of the most rugged of Nature's paths, where, in spite of the help extended to us, we have to exert our own powers to the utmost lest we should fall behind. The first lecture in the book, "On Capillary Attraction," is one of the best examples that could be found of Sir W. Thomson's power of carrying his reader or his hearer along with him, and letting him see, as it were, the actual working of his brain.

The author tells us that in these lectures he has tried to lay bare the principles of this difficult subject to "those people who fancy that they cannot understand sextuple integrals," a class which is perhaps more numerous than he imagines. He has certainly succeeded in making the subject comprehensible to those readers who, though unable from want of technical knowledge of the higher mathematical analysis to follow the ordinary expositions, are yet able to follow a course of sustained scientific reasoning.

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This lecture is one which will be of the greatest assistance even to mathematicians who are well acquainted with the analysis of the subject, for the mathematical scaffolding by which we succeed in scaling heights which would be otherwise inaccessible always obscures some portion of the view, which only opens itself out to its fullest extent when some great master-mind, after having used the scaffolding for the first ascent, has succeeded, by the aid of the closer view thus obtained of the difficulties of the way, in opening up an independent path to the summit. The lecture on "Electrical Units of Measurement," delivered at the Institution of Civil Engineers in 1883, and that on "Electrical Measurement," delivered in connection with the Loan Collection of Scientific Apparatus, at South Kensington, in 1876, are the two which will be of most direct interest to our readers, and we must earnestly recommend those who have not already done so to read, mark, learn, and inwardly digest them. There are very few electricians, even though fairly well versed in the principles of the modern absolute system of electrical measurement, who will not find their views on the subject considerably widened and deepened by the careful study of what Sir W. Thomson has to say about them in these pages.

The history of the development of electrical measurement affords one of the very best examples of the value of scientific theory, and the reader, be he a scientific electrician or a practical engineer, who has learnt this lesson, will treat with equal contempt the sneers of the "transcendental theoriser who builds his elaborate structures upon utterly inadequate experimental foundations, or upon the shifting sand of unsupported hypothesis" and the ignorant drivelling of the rule-of-thumb man, who, dimly conscious of the fact that his brain-power is not equal to the task of becoming a scientific engineer, fears that his bread will be taken out of his mouth by his more highly gifted competitors, and, like the fox who had lost his tail, tries to persuade all the other foxes that tails are inconvenient and unnecessary appendages, and had better be cut off.

The lecture which bears the title, "Steps towards a Kinetic Theory of Matter," will be read with exceptional interest by those of our readers who were fortunate enough to hear Sir William's inaugural address this session to the Institution of Electrical Engineers, for here they will find developed in somewhat more detailed form a theory which was almost too briefly touched upon in the inaugural address to enable most of those present, to whom the subject was new, to obtain a very clear grasp of it, in spite of the interesting gyrostatic experiments by which it was illustrated.

The lecture on the "Six Gateways of Knowledge" deals with our means of perception of the external world. The six gateways consist of the well-known five senses, together with the sense of touch, divided into two senses, viz., the muscular sense, or the sense of force, and the sense of heat, a distinction which certainly appears to be reasonable, for the sensation of heat is no more like the sensation caused by the action of force than is that of light. In addition to the lectures we have especially noticed, the book contains others of the greatest interest on "The Size of Atoms," on the "Wave Theory of Light," and on "The Sun's Heat," together with brief abstracts of lectures on "Elasticity Viewed as Possibly a Mode of Motion," and on Maxwell's "Sorting Demon."

ELEMENTARY THEORY OF THE "ARMATURE REACTION" TYPE.*

Alternate-Current Motors.

BY M. W. RECHNIEWSKI

If we take an ordinary continuous-current dynamo or motor, short-circuit the armature through the brushes, place the latter at an angle of 45deg. with the magnetic axis A B (Fig. 1), and send an alternating current through the field magnets, it is well known that it will work as a motor. The armature will not start from rest, but it rotates in whichever direction it may chance to have been started with a velocity which tends continuously to increase. The couple increases, moreover, with the velocity; hence it is so far clear that a practicable motor can be constructed upon this basis. But in order that we may be enabled to choose the best proportions, and that we may understand what can reasonably be expected from this type of apparatus, it will be necessary to study the manner in which the couple is produced. In this case, as in that of the transformer, we shall assume that the alternating current follows the sine law. We will divide the armature (Fig. 1) into four regions, *a b*, *b c*, *c d*, and *a d*. Now, when the mag-

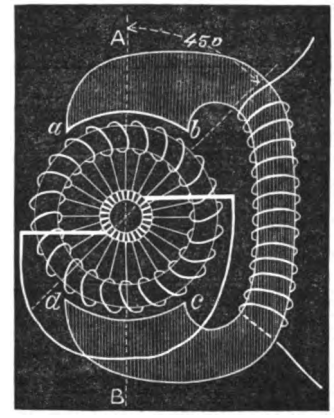

FIG. 1

netic induction varies in the system an electromotive force is, of course, produced in each turn of the armature wire. In the regions *a b* and *c d* the E.M.F.s thus generated are equal and opposite on either side of the magnetic axis, and mutually cancel one another. On the other hand, in the parts *b c* and *a d* the E.M.F.s generated act together to produce a difference of potential at the brushes, and an (alternating) current, therefore, traverses the circuit of the armature. Returning to the

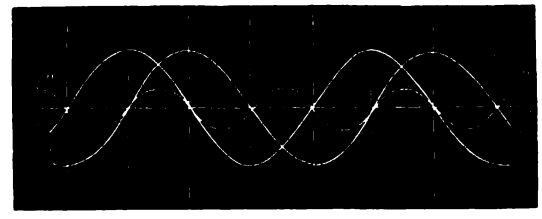

FIG. 2.

regions *a b* and *c d*, we see that the couple produced by the current in the coils and the alternating field tends to cause rapidly reversed impulses of equal extent and duration; consequently this contributes nothing to the rotation of the armature, and the machine cannot start of itself.

In Fig. 2 let *s* represent the curve of magnetic induction due to the field, then *s'*, the curve of current in the armature, will be displaced 90deg., or, in other words, will have a lag of a

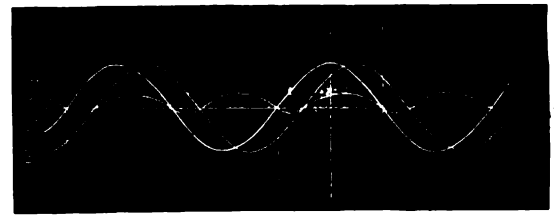

FIG 3

quarter-period.* The couple produced, which will be simultaneously proportional both to the current and to the induction (being zero when either *s* or *s'* is zero), may be represented by the curve *s''*, in which the areas cross-hatched above and below the axis represent the effect in either direction respectively.

Let us now suppose that the armature is already in movement. This introduces a new factor due to the E.M.F. gene-

* Extracted from an article in *La Lumière Electrique*, May 18th, 1889.

* The author here neglects the effect of self-induction in the armature.

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rated in the coils by their own displacement in the magnetic field. This new E.M.F. is evidently proportionate to the field [and to the speed of rotation] and its phase is necessarily identical with that of the field; it can, therefore, be represented by s in Fig. 2 and Fig. 3. The current in the armature is now due to the combination of these two E.M.F.s which differ in phase, and it may be represented by a sinusoid s''' (Fig. 3) displaced by a certain arc ϕ from that of the field itself. The dynamic couple, being at each instant proportional to the product of the ordinates ss''', will now be represented by a curve, s^1, in which the areas enclosed upon one side of the axis are greater than those upon the other side [the difference depending, of course, upon the value of the lag, ϕ, which is really a very complex function]. It is, moreover, easy to show that the effect is greater in the same direction as that of the previously existing rotation; consequently the speed of the armature tends continuously to increase, and it can be made to do work.

The objection of having to start the motor by hand may be overcome by introducing into the armature circuit an inductive resistance sufficient to establish the required lag, which can be withdrawn as soon as the machine has commenced to run.

BOARD OF TRADE INQUIRY ON THE ELECTRIC LIGHTING OF THE CITY OF DUBLIN.

On the 6th inst. Major F. A. Marindin, R.E., one of the Inspectors of the Board of Trade, opened an inquiry in Dublin to hear an application by the Alliance and Consumers' Gas Company for permission to open certain streets in the city for the purpose of laying electric lighting cables for lighting of private houses. The Gas Company contended that under their Acts of Parliament they required no License and no other permission than the one they sought. The Corporation opposed the application.

Messrs. George Wright, Q.C., and Alex. Holmes (instructed by Messrs. D. and T. Fitzgerald) appeared for the Gas Company.

The Right Hon. S. Walker, Q.C., and Mr. Richard Adams (instructed by Mr. J. MacSheehy) appeared for the Corporation.

The INSPECTOR said this inquiry was of a novel character. The ordinary inquiry was where a company was seeking by means of a Provisional Order to get power to supply electricity or water where the local authority withheld its consent. In this case the company was moving the Board of Trade to exercise certain powers which they said they had under their Acts, but he should treat it as if it were an ordinary case, and ask the Gas Company to give him any reasons they could why the Board of Trade should exercise those powers. Of course he had nothing to do with the legal interpretations of these sections.

Mr. WALKER said he wished to guard himself against being taken as assenting to the proposition of the Gas Company. This inquiry proceeded on the assumption that they had a statutory authority which enabled them to do everything except open the streets. The contention of the Corporation was that the Gas Company had no such power, and if they had it they should obtain a License or a Provisional Order under the Act of 1882. Even if the Board of Trade gave the company the right now claimed, the Corporation could proceed against them hereafter by injunction, and would do so. He was, therefore, to be taken as protesting against the inquiry.

The INSPECTOR: All I have to inquire into is whether, supposing they have the right, it is desirable they should exercise it.

Mr. GEORGE WRIGHT said the Act of 1866 was the one by which the Alliance and Dublin Consumers' Gas Company was formed for the purpose of "making and supplying gas and other improved means of lighting for public and private purposes;" and it had always been maintained by the company that under that they had the power of supplying electric light. In 1883 the company went to Parliament to get powers to raise a capital of £286,000. About that time the company purchased the plant of the Dublin Electric Lighting Company, and had been since supplying electric light to a number of firms in the city, to the great satisfaction of the public, their right to do so never having been questioned. It had been supplied by overhead wires, but to that system there were many obvious objections, and it was necessary that the company should have power to open up the streets and lay them underground. The Gas Company had power to open the streets for all the purposes of their acts; and if the legal position of the company was right, that they had the power to supply electric light also, it would follow, and they had been so advised by eminent counsel, that they had the same power, or at all events up to the Act of 1883, to open up the streets for the purpose of laying these electric wires. By the Act of 1883 a certain restriction was imposed on them which made this inquiry necessary. That restriction did not take away from them the power to open up the streets, but said that they should not be at liberty to do so without the permission of the Board of Trade, who might impose such conditions for the public safety as to them might seem reasonable. To that the company had no objection. The Corporation of Dublin had already got a License for public lighting, and had power to open the streets wherever they liked, and the Gas Company only asked the same permission for private lighting. The scheme the company brought forward was this: Of old capital there remained £13,000—that was of the capital raised in 1866; that capital was not tied up in any way, not subject to any restrictions, and was now applicable to any scheme of electric lighting that they might devise. They had a further sum of capital under the Act of 1883 of £383,000; that they could not touch without getting the sanction of the Board of Trade, for the 25th Section of that Act provided that it should not be applied to the supply of electricity without the sanction of the Board of Trade. It might be that in the future they would ask for that sanction, but in the present application they did not. As to any excess in the present estimate over the £13,000 capital there would be no difficulty about raising it. As to the works themselves, the area was a rather populous, busy, and wealthy part of the town, where there was a very great demand for electric lighting. The citizens of Dublin, who were more interested in this matter than anyone else, were of opinion that it was better that all this should not be in the hands of any one company, whether that was the Gas Company or the Corporation. They had had numerous applications from persons living within the proposed area to supply them, but they could not do so at present without risk by the system of overhead wires.

The INSPECTOR: Do you contend that you are empowered under your Act to supply electric light to the whole of these thirteen townships?

Mr. WRIGHT: Certainly, and the whole metropolitan area.

Mr. ARTHUR PORTE, Electrical Engineer, said that the Gas Company proposed to use secondary batteries combined in sub-stations. In the area proposed to be taken in there were about 600 houses, a large number of public institutions and clubs. Within the last year they had received applications from 34 or 35 separate houses for a supply of the electric light. The scheme would cost from £13,000 to £16,000.

To Mr. Adams—There was a loss of about £100 a year at present on electric lighting. The Electric Lighting Company charged 5d. an hour for an arc lamp, the Gas Company charged 8d., but in one case where they had a large consumer they charged less; for incandescent lights the Electric Company proposed to charge ½d. an hour, the Gas Company charged 1d. He had no objection to the Corporation and the Gas Company operating in the same area.

Do you agree with this: "Represent the undesirability or serious danger of rival electric wire systems running underground amidst gas pipes, and that the inevitable consequence will be defective insulation on the one hand and leakage from gas mains on the other if running concurrently?"—There should be no difficulty if they are well laid.

Mr. WRIGHT asked where the quotation was taken from.

Mr. ADAMS said from a petition by Mr. Pembroke Stephens and Mr. A. M. Sullivan on behalf of the Gas Company against an electric lighting scheme.

Prof. G. FORBES, F.R.S., deposed he had examined the scheme prepared by Mr. Porte; he believed the estimate was very closely accurate. The plan was a very good one indeed, and would work very well; it would be a most thorough and satisfactory working of the district, very much more so than one was accustomed to see.

Mr. HOLMES: What is your opinion generally as to competition in these matters of electric light?—I do not like monopoly. Undoubtedly where competition comes in consumers are better satisfied in a great number of ways, not only as to price but also as to having their complaints attended to, and so forth.

Cross-examined by Mr. ADAMS: Witness said the continuous-current motors had been used largely before, and distribution from a central station had also been used largely; but the two in combination, as proposed here, had not been used before on so large a scale. Several other witnesses were examined on behalf of the Gas Company, and then

Mr. WALKER opened the case for the Corporation. There was nothing in any Act of the Gas Company to authorise them to supply electric light without coming to the Board of Trade in the usual way. When the Corporation applied for a public License the Gas Company brought in objections, but they ran away before the inquiry. One of the heads of their objection was, "It is the intention of your memorialists to apply this year for a Provisional Order under the Electric Lighting Act, 1882, to obtain the necessary powers." Therefore they had it under their own hand that they were then about to do what they were bound to do, namely, proceed by Provisional Order; but because they knew that the Corporation would not consent to a License they had not done so. And now they tried to avoid it by saying that they had power under the Act of 1866. The Corporation were the local authority for the whole city, and had already obtained a License for public lighting; they intended to proceed and obtain a License for private lighting, and they had unlimited powers of borrowing. Now, what was the position of the Gas Company? They had exhausted all the capital which might have been applied under the previous Acts—if they were right—to electricity, and they now intended to borrow under an Act which preveuted them applying any of the money to electricity, and they would put that capital in place of the old. It was absurd to suppose that one farthing of that capital could be legally applied to the purposes of electricity. It was an extraordinary proposition that a gas company should, out of the city, pick out this little bit of residential portion and apply a limited capital of £12,000 to it, leaving the less wealthy district to be supplied by the local authority. Would the Board of Trade sanction a scheme which never could go beyond that limited area? Was it to be supposed that the company would run this electric light against the gas supply; and, having on one hand a gas supply yielding 10½ per cent., and on the other this novel experiment of electric light, was it not obvious that their object was to smother the electric light in its cradle? He submitted that the application was wholly illegal and should be refused.

Mr. EDWARD MANVILLE, examined by Mr. ADAMS, stated that he was an electrical engineer. He knew the part of the city proposed to be lighted by electricity by the Gas Company, and he was aware that it included the principal public buildings of Dublin—Trinity College, the Museums, the National Gallery, the principal hotels and clubs. He had heard it stated that there were 600 houses in that particular locality, and, taking it on an average of 40 per house, it would require 24,000 lamps to

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light it. According to the provision made at the distributing station, the number of lamps that could be supplied under this scheme would be 2,500, and in case of accident there was no proper provision for the duplication of machinery.

The Right Hon. the LORD MAYOR, M.P., examined by Mr. ADAMS, said: The Corporation had undertaken and carried out a scheme for supplying the city with water, and that scheme had given great satisfaction to the citizens of all classes, and he did not believe there was a city in the world which, in point of the price and amount of supply of water, was in a better position than Dublin. The Corporation administered a sum of £300,000 a year, and, though the accounts were audited by an auditor of the Local Government Board, such a thing as a surcharge was unknown. The present position of the lighting of the city was unsatisfactory, and there was a strong and earnest desire that some steps should be taken to improve it. The present proposal of the Gas Company he regarded as one confined to the residential part of the city, and in so far a class proposal. The effect of such a scheme would be to take out the oyster and leave the shell, and to confine the electric lighting to fashionable quarters.

The INSPECTOR asked what powers the Corporation proposed to take to light the city with electric light?

The LORD MAYOR said they proposed that there should be compulsory powers to light a certain area, and then that the other areas of the city should be lighted on requisition of the inhabitants in particular districts.

Mr. THOMAS MAYNE, M.P., was next examined by Mr. ADAMS. He stated that he was a director of the Electric Lighting Company of Dublin. He believed it was the first company that went into electric lighting on a commercial basis without stock-jobbing arrangements. They thought the plant they bought the best at the time, but before they went into liquidation they found that it was not. It was necessary to buy new plant and call up new capital for the purpose, and, as there was a scare at the time in electrical lighting matters, the shareholders got frightened, and thought it better to go into liquidation. He thought if the company continued they would make a fair profit. As it was the plant was sold by the liquidator to the Gas Company for £3,000. They only charged 5d. per arc lamp, whereas the Gas Company charged 8d. per lamp.

Mr. JOHN BEVERIDGE, Town Clerk, examined by Mr. ADAMS, said the Town Council since 1881, when some valuable property came into the hands of the Corporation, had taken the matter of electric lighting for the city into their consideration. There was water-power on that property, which was situate at Island Bridge, and it was thought this water-power might be utilised for the public lighting of the city with electricity. The Corporation had large unexhausted borrowing powers, and these powers might be used in this matter. Some time ago they got a license for the public lighting of the city, and since then they took into consideration the question of private lighting. In regard to private lighting the Corporation proposed to leave it optional with the contractor to avail himself of the Island Bridge site, or any other site that would prove more economical.

The Inquiry was then adjorned to the following day.

FRIDAY, JUNE 7.

On the resumption of the Inquiry,

Mr. ADAMS replied for the Corporation. This application was a clear attempt to evade the law, and by a short cut to get rid of the precautions which Parliament had imposed upon them. Their contention was that in the Act of 1866 the words "improved means of lighting" included electricity. But when they promoted a Bill in 1879 they put in words defining "improved means of lighting" as including electricity, but Parliament struck them out, thus showing that they had not these powers. The interest of the Corporation was to develop the electric light in every possible way, and to try and provide the citizens with a better and cheaper light than gas, which had the monopoly. It would be a monopoly if all the means of lighting were in the hands of the Gas Company. The interest of the Gas Company was to stifle and strangle the electric light. They were now in the happiest position in which a company could be. The shareholders were drawing 10 per cent., the directors received handsome remunerations, and the officers princely salaries, and they regarded the electric light as a troublesome intruder on this Paradise. If the electric light were given to the Corporation they would nurse it and cherish it in the interests of the citizens, and make it a giant. If it were given to the Gas Company they might fondle the baby in public, but in private they would pinch it and starve it, and in the end they would wring its neck, and bury it in the coal-hole. At the end of 23 years they had only nine customers, and they would not have moved now only that the Corporation had taken steps to procure a private licence. Then as to the estimate, there was £16,000 worth of work to be done, and the company had £10,000 with which to do it. It would be a monstrous thing to allow this Gas Company to cripple the Corporation by cutting out of the city this prosperous and important bit. Weight must be given to the opinion of the local authority, which really ought to be supreme in these matters, and whose supremacy had received on a recent occasion Parliamentary sanction. The Corporation, representing a quarter of a million citizens, had unanimously decided to oppose the project, and counsel asked the Board of Trade to refuse it as not being a *bonâ fide* but a bogus application.

Mr. HOLMES replied. He did not come there to impugn the character of the Corporation or their capability to carry out this work, but he believed the Gas Company had shown that they were equally competent, and the charges which Mr. Adams had made against them ought not to be made without evidence. If the Gas Company were wrong in law, the moment they attempted to open the streets the Corporation could apply to the Courts of Law for an injunction or a mandamus; and they ought not to have appeared at this Inquiry at all if they believed they had the law on their side. The Gas Company said there was a demand in the city of Dublin for the electric light, and they had shown it by the number of applications signed by eminent professional and business men which they had produced. The company said they were capable of meeting that demand by the scheme they had produced. With regard to the question of capital, the company said they had £13,000 of the old capital applicable to electrical lighting; the maximum expenditure of £16,000 would be sufficient to supply the whole of this area; but if within the next twelve months there were applications to light a third of the area, it would be a very fair demand. Therefore the capital was more than sufficient to meet any immediate call; and if in three or four years' time they wanted more capital, he was sure the Board of Trade would give them permission to apply some of their new capital for the purpose. All the Gas Company asked was to be allowed, in open competition with anyone else, to supply electric light in a portion of the city. Some of the most eminent business men in the city had been examined, and had proved that in their opinion it would be in the interests of the citizens that this application should be granted. On the other there were only members of the Corporation and their *employés* examined; and it should be remembered that the Corporation were not elected on the question of electric lighting. He respectfully submitted that, under these circumstances, the Gas Company, he would not say were entitled, but they asked the Inspector for a favourable report, and asked the Board of Trade for the license they sought.

The Inquiry then terminated.

BOOKS, &c., RECEIVED.

"Torpedoes and Torpedo Warfare." By C. SLEEMAN. Second Edition. (Portsmouth: Griffin and Co.)

"Spacial and Atomic Energy." Part I. By Frederick Major. (London: Eyre and Spottiswoode.)

"The School of Mines Quarterly." Vol. X., No. 3. (Columbia College, New York.)

"The Comparative Danger to Life of the Alternating and Continuous Electrical Currents." By Harold P. Brown.

"List of Subscribers in the Scottish North Central District of the National Telephone Company." (Dundee: R. S. Barrie.)

"The 'Lancaster' Catalogue." (Manchester: Lancaster and Tonge.)

"Alternating Currents of Electricity." By T. H. BLAKESLEY, M.A. Second Edition, enlarged. (London: Whittaker and Co.)

"Abstracts of Papers in Foreign Transactions and Periodicals." (Published by the Institution of Civil Engineers.)

"Articles, extraits de diverses Revues Scientifiques, sur les Accumulateurs Electriques." By ALBERT BANDSEPT. (Brussels: Imprimerie Belge.)

"*Journal* of the Institution of Electrical Engineers." Vol. XVIII., No. 80. (London: E. and F. N. Spon.)

Illustrated Catalogue and Price List of the Hibbard Electric Manufacturing and Supply Company, Limited. (Montreal.)

"The Working and Management of an English Railway." By GEORGE FINDLAY. (London: Whittaker and Co.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, June 14th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse. "Quartz Fibres." By C. V. BOYS, A.R.S.M., F.R.S.

SATURDAY, June 15th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Idealism and Experience in Art and Life." By Prof. W. KNIGHT, LL.D.

WEDNESDAY, June 19th.

ROYAL METEOROLOGICAL SOCIETY.

7 p.m. Ordinary Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster. The following Papers will be read:—"The Climate of British North Borneo." By ROBERT H. SCOTT, M.A., F.R.S. "On the Variation of the Temperature of the Air in England during the period 1849 to 1888." By WILLIAM ELLIS, F.R.A.S., F.R.Met.Soc. "Atlantic Weather and Rapid Steamship Navigation." By CHARLES HARDING, F.R.Met.Soc. "Meteorological Phenomena observed during 1875-87 in the Neighbourhood of Chelmsford." By HENRY CORDER. "Rainfall in China, and Meteorological Observations made at Ichang and South Cape in 1888." By W. DOBERCK, Ph.D., F.R.Met.Soc. "Recent Thunderstorms, illustrated with Photographs of Lightning." By Mr. MARRIOTT.

SATURDAY, June 22nd.

PHYSICAL SOCIETY.

3 p.m. "Researches on the Electrical Resistance of Bismuth." By Dr. EDWARD VON AUBEL.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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LOCAL GOVERNMENT AND THE ELECTRIC LIGHT.

Some rather important extension of communal principles may naturally be expected from the popular character and powers conferred on the newly-created County Councils under the Local Government Act. An indication of this has already been given in the extreme self-assertiveness of the London representative body, notably in regard to the administration of the Electric Lighting Act, which the Council is evidently prepared to take on its own shoulders forthwith. Provincial Councils will not be backward in this respect we may be sure; and, their example reacting on the large towns and cities, a general desire is manifesting itself among local authorities to be doing something to justify their existence. The first thing that occurs to them to do is to set up business on their own account as suppliers of Gas and Water. Next in order will come the more ambitious aim of providing the Electric Light, an aspiration which has already found expression in the opposition of certain local vestries to the granting of Provisional Orders to outsiders, on the ground that if anybody is to have exclusive rights in this department of industry they ought to be vested in the local authorities. Only one English Corporation has as yet commenced the experiment, and that on a

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limited scale, with not very encouraging results so far; but the rest are living in hopes that by delaying the applications of independent companies, sufficient knowledge of it may be gained to justify the business being started with capital borrowed on the security of local rates.

A curious illustration of this anxiety to extend their functions on the part of local corporations comes ready to hand from the City of Dublin, where an application on the part of the Gas Company to lay down underground wires for electric lighting purposes is opposed, partly no doubt because of misgivings as to the *bona fides* of the company, but chiefly because the Corporation itself wishes to retain the supply in its own hands, as it has already the supply of water. The evidence given before Major MARINDIN by the LORD MAYOR and members of the Dublin Corporation went to show that the management of the water supply is as pure as the water itself, and that altogether the chief city of Ireland is a perfect model of incorruptibility and public spirit. We are extremely glad to hear it, especially as reports of an opposite character have often reached us on this side of the Channel. But be that as it may, something more than good intentions is needed for the efficient management of electric lighting business; and, other things being equal, we should say that the Gas Company is more likely to command the required technical knowledge than is the Dublin or any other popularly elected municipal body. Not only this, a private company which is working for profit is more likely to conduct its business on economical lines than is a Local Authority with unlimited powers of borrowing and virtual irresponsibility as regards its expenditure. The shareholders of the Dublin Gas Company would constitute a very practical check upon extravagance or incompetence in the management of its affairs; the ratepayers of Dublin, as experience tells us everywhere else, are no check whatever on the doings of their representatives. Charges for a commodity supplied by the local authorities afford no criterion of the actual cost to the community, as the nominal price may be very low while the taxes to maintain it at that figure may be very heavy. In the case of Dublin, where the city authorities propose, like the Gas Company, to supply electricity to a limited area, the whole city would be taxed with the cost of the installation, and with any loss on the transaction if it failed, as probably it would, to be remunerative.

As, however, the dispute upon which Major MARINDIN has just been called to adjudicate in Dublin is complicated by the alleged shortcomings of the Gas Company, and its sinister motives in wishing to appropriate one of the best areas to the exclusion of a dangerous rival to the Gas interests, we are not prepared to offer any decisive opinion as to what the Inspector's verdict ought to be. Probably the Gas Company may be permitted to work under a Provisional Order if it chooses to apply for one. At present it claims to have the right to take up the streets and to supply electricity as "an improved method of lighting" under its original charter as a Gas Company. It will be interesting to note how this point will be decided; for, doubtless, the Dublin Company is not the only Gas Company that has a similar clause in its Act of corporation; and if their claims are upheld, many of the companies would be thus enabled to supply the electric light outside the provisions of the Electric Lighting Amendment Act, and consequently not subject to the purchase clauses incorporated in that or the Act of 1883. All that they would have to do would be to satisfy the Board of Trade that their scheme of supply was in accordance with regulations, and their system of wiring free from any danger to the public. We cannot believe that the Act of 1888 contemplated any such avoidance of its provisions; although, on the other hand, we should welcome any *bonâ fide* desire on the part of the Gas Companies to turn their attention to the business of electric lighting.

On the general questions of municipal socialism we may, perhaps, be content to let things take their natural course, circumstances varying in various localities, and what would be reckless speculation in one place might be judicious enterprise in another. For the present the local authorities as a rule will probably be well-advised in leaving the extremely technical business of electric lighting to professional experts, confining their trading instincts to the supplying of absolute necessities such as gas and water. If the subject of communal trading ever becomes the burning question here it threatens to be ere long in America, the sale of electricity will probably be excluded from consideration as a luxury not to be compared in importance with railroads, postal service, telegraphs, gas-light, and water. In the United States the acquisition by the State or by the local authorities of all these classes of undertakings, plus the electric lighting, is now being discussed very warmly, and is likely to become a serious political agitation. We say political, for although political ideas are disclaimed, it is notorious that matters of this sort cannot long be kept out of the political arena. "Spoils to the victors" is an established maxim of political warfare in America; and those who conscientiously oppose the tendency to Communism in that country declare it as one of their strongest objections that everybody will be compelled to become a politician, whether he likes it or not, if only to prevent the wholesale plunder which is one of the recognised rewards of political triumph, and which would be greatly enlarged if the supply of every necessity of life were to fall into the hands of the municipalities. We confess to some such apprehensions in regard to our own local affairs, which even now are sufficiently disturbed by the political strife of the times; and we think, therefore, that the ratepayers should keep a very close watch on any project whatever for extending the system rashly beyond its present limits.

ELECTRIC MOTOR REGULATION.*

BY FRANCIS B. CROCKER.

Although this subject is one of great scientific and practical interest, it has not been very frequently or very fully treated up to the present time. Of course, motor regulation is very similar to dynamo regulation, but it is by no means identical with it, and it deserves and requires separate treatment. I do not think it is much exaggeration to say that at the present time there is no subject more generally important to electrical engineers than motor regulation. Considering this fact, it is certainly remarkable that the literature of the subject is so limited. We find stray articles in electrical periodicals, rarely more than a description of one particular invention, and in electrical books, regulation is referred to incidentally in connection with descriptions of the various motors. There is also, to be sure, usually one short chapter devoted to this subject, but it is apt to be either very general, merely mentioning a few regulating devices, or else it is confined to the mathematical analysis of some one particular method.

Motor regulation is a subject which is somewhat confusing, and requires, therefore, accurate definition of the quantities and conditions which enter into it. One case is, at first sight, very similar to another, and yet more careful consideration will show, very likely, that it is exactly opposite. Take, for example, the two commonest and most important cases, viz., the constant-potential and the constant-current motors. The conditions of the two cases are precisely opposite, and the solution of the problem is, naturally, entirely different. To maintain a motor at a constant speed with a variable load, on a constant potential circuit, which is the case of the ordinary shunt motor on the regular 110-volt incandescent circuit, is a very easy problem—in fact, it solves itself. A simple shunt-wound motor will run at a practically constant speed on a constant potential circuit, even if the load varies from zero up to the full capacity of the motor. Now this form of motor is exactly

* A Paper read before the American Institute of Electrical Engineers, New York, May 22, 1889.

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what we would use, even if we did not care to have it regulate. It is customary, to be sure, where very close regulation is required, to wind constant potential motors differentially, *i.e.*, with series as well as shunt coils, but this is not essential for ordinary work.

The case of the constant-current motor, on the other hand, is as difficult as the first is easy. It seems as if it had to bear the burden of both. Neither a shunt-wound, nor a series-wound, nor a compound-wound motor can be used practically on a constant-current circuit to maintain a constant speed with variable load. The ordinary series-wound motor, which is the natural and common form for the constant-current motor, will race away when the load is taken off and increase in speed until it tears apart or strains the armature and ruins the machine. We require some special and very effective device to accomplish the regulation in this constant-current case, and it seems to happen that almost every device that has been thought of has serious difficulties and complications. The ordinary, and what would seem to be the best, solution of this problem is to vary the magnetic effect of the field upon the armature directly in proportion to variations in the load. This is effected by cutting out the field coils, and by other methods which will be described later. But there are difficulties with almost all these plans.

These two cases, which, as already stated, are the commonest and most important which occur, and yet which are so very different in almost every respect, give a general idea of what we have to deal with in motor regulation.

In order to fix and hold the rather numerous quantities and conditions that present themselves in connection with motor regulation a tabular statement of them is given below :—

TABLE I.—Principal Methods of Motor Regulation.

1. Shunt winding. (*See* Fig. 1).
2. Differential winding. (*See* Fig. 2).

Varying external resistance in series with—

3. Armature.
4. Field. (*See* Fig. 1).
5. Both armature and field.

Varying internal resistance of—

6. Armature.
7. Field by cutting out coils in series. (*See* Fig. 3).
8. Field by cutting out coils in multiple arc. (*See* Fig. 4).
9. Field by grouping coils in series or multiple arc.
10. Both armature and field. (*See* Fig. 5).

Varying shunt in multiple arc with—

11. Armature.
12. Field.
13. Both armature and field. (*See* Fig. 6).
14. Varying current in separately excited field.
15. Shunting field magnetism. (*See* Fig. 7).
16. Short-circuiting field magnetism. (*See* Fig. 8).

Varying commutation by—

17. Shifting brushes. (*See* Fig. 9).
18. Shifting commutator.
19. Shifting magnetic resultant.
20. Moving pole pieces away from armature. (*See* Fig. 10).
21. Moving armature away from pole pieces. (*See* Fig. 11).

In Table I. motor regulation is divided into hand regulation, which it happens is almost always used for varying the speed of a motor, by a hand switch (Fig. 1 for example), and automatic regulation, which is almost always used to maintain a constant speed, and which is usually accomplished in one of the three following ways :—First, by a centrifugal governor similar to that of the steam engine, operating a switch or other device, Fig. 3 ; secondly, by a dynamometric governor, *i.e.*, a mechanism through which the load or torque of the motor is transmitted, which may also operate a switch and vary the power of the field by the direct effect of changes in the load ; thirdly, by an electro-magnetic device, such as a solenoid, through which the current, or a portion of it, is passed, which causes the core of the solenoid to move and operate a switch in accordance with variations in the current, Fig. 9.

The table gives the principal methods used to regulate motors. These consist of different arrangements and combinations of parts to produce different effects or changes in the working of the motor, and they constitute the means which we have to employ to accomplish a certain object in motor regulation. Method 1 is simple shunt-winding, which consists in exciting the field-magnet with a circuit of comparatively high resistance in multiple arc with the armature (Fig. 1). This maintains a motor at constant speed with varying load on a constant potential circuit, and does this all by itself, as it were, without any trouble, as already pointed out. The reason for this is that the field, being fed with a constant potential, is therefore of constant strength, and a slight variation in speed of the armature, about 5 per cent., will vary the current in it from zero up to its full capacity, and therefore vary its power to an equal extent.

Method 2 is differential winding (Fig. 2), which is a refinement of the first, by which an almost absolutely constant speed, *i.e.*, within 1 or 2 per cent., may be practically maintained. This consists in winding a series coil of comparatively few turns upon the field magnets, in addition to the shunt-winding in the previous case, the series coil being wound in the opposite direction and opposed magnetically to the shunt coil. The effect of this is to slightly weaken the field magnetism as the load on the armature, and consequently its current increases. This tends to increase the speed of the armature and counteract its tendency to slow down with increased load, thereby almost entirely eliminating even the small variation of 5 per cent. in speed which occurs in the ordinary shunt motor. The paradoxical fact that a shunt motor increases its speed with the weakening of the field-magnet is well known, being due to the lowering of the counter electromotive force and consequent increase of current in the armature as the field magnetism is reduced in intensity.

In the next three methods the external resistance in series with the armature or field, or both, is varied. Method 3 would be very wasteful, and is hardly allowable in good practice, because it is simply destroying the main current to put resistance in the armature circuit. Method 4, varying the resistance in the field circuit, is very much less objectionable, and is very convenient and common (Fig. 3). This mode can be adopted with a very small loss of current, because the field current is only a small part of the total current used in the motor, and the loss of a portion of this small fraction is practically insignificant. Method 5, putting external resistance in series with both the armature and field, is open to same objection as Case 3, since it throttles and destroys part of the main current.

The next five modes of regulation, 6, 7, 8, 9 and 10, are theoretically more economical than the preceding, because we vary the internal or useful resistance instead of adding external or dead resistance. Method 6, in which the internal resistance of the armature is varied, is very difficult to carry out in practice, simply because it is hard to get at and change the connections of the armature while it is revolving. One of the few ways devised to accomplish this is to wind the armature with two or more circuits connected to a corresponding number of commutators, whereby one or more of these circuits may be used, thus varying the internal resistance and torque. This is clumsy, and practically little better than using two or more separate motors.

Method 7, cutting out the field coils in series, is a very simple and common plan. It is the ordinary way of regulating constant-current or other series-wound motors. This method, or some modification of it, is one according to which the constant-current or "arc" motors of the Baxter, "C. and C." and Excelsior companies are constructed. Method 8, of cutting out field coils in multiple arc, is shown in Fig. 4, and is especially applicable to shunt-wound motors. The different layers, for example, may be respectively connected to the contact points of a switch and thrown into circuit successively, the innermost layer first, &c., thus obtaining the most economical result.

Method 9, of grouping the field coils in series or multiple arc, produces very great variations in field resistance and is a combination of the two preceding cases. Like them, it consists in winding the field with separate circuits which are connected to a switch. This is employed in street-car motors to obtain the great variations in resistance and power required of them.

Method 10 is also merely a combination of two or more of the four preceding cases. A simple way of carrying it out is illustrated in Fig. 5, and consists in connecting the armature and field either in series or in multiple arc, by which a great variation in the total internal resistance of the machine is obtained.

The next method, No. 11, is open to the same objection as No. 6, because when the armature is shunted the main current of the machine is affected. This is, however, less objectionable than dead resistance, because in most cases it is better to divert the current than to destroy it.

Method 12, like methods 4 and 7, is a useful and common one, because in shunting the field we are merely handling a very small fraction of the total current.

Method 13, varying a shunt in multiple arc with both armature and field, is wasteful, like No. 11. It was, however, the plan by which the first arc motors were regulated, a variable shunt being placed in the main circuit and the motor connected to the terminals of the shunt.

The variations in the shunt, of course, throw more or less current through the motor, thereby varying its power as required.

Method 14, varying the current in a separately excited field, is merely historical, as this class of motors has gone out of use. The plan, however, is a very effective one, because, of course, it is very easy to control the field current when it is produced by a separate source.

Method 15 is shown in Fig. 7, and consists in shunting the field magnetism, *i.e.*, diverting the lines of force from the armature through some other path. In the arrangement shown in Fig. 7,

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there is a simple series-wound motor with consequent pole field magnet, and, if the coils exciting one magnetic circuit are short-circuited, it is evident that the magnetism produced in the other magnetic circuit will be short-circuited or shunted by the former.

We now come to methods 17, 18, and 19, in which the line of commutation is varied. The first is the well-known plan of shifting the brushes. This is very effective and easily carried out, and has, therefore, been used quite extensively, but it has the very serious and almost prohibitory objection that when the brushes are moved from the neutral point they spark very badly. This may be remedied to a slight extent by some heroic plan like blowing out the spark produced. But, as sparking is one of the worst drawbacks of a motor, it hardly seems as if this method of regulation would be permanent.

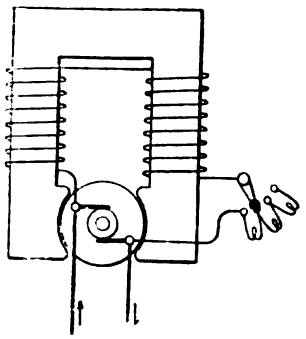

FIG. 1.—Shunt Motor, with Variable Resistance in Field Circuit.

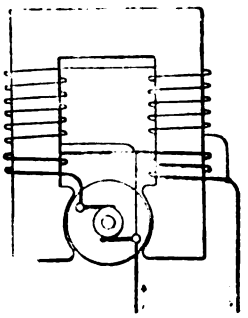

FIG. 2.—Differential Motor. Self-Regulating.

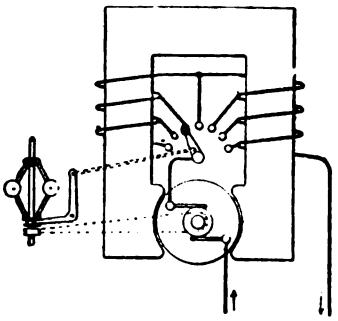

FIG. 3.—Series Motor with Switch for Cutting Out Coils in Series.

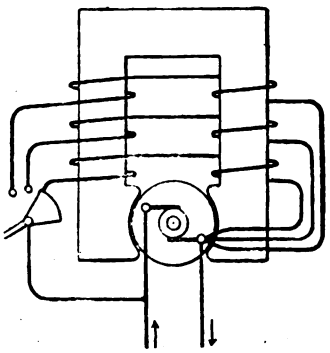

FIG. 4.—Shunt Motor with Switch for Cutting Out Field Coils in Multiple Arc.

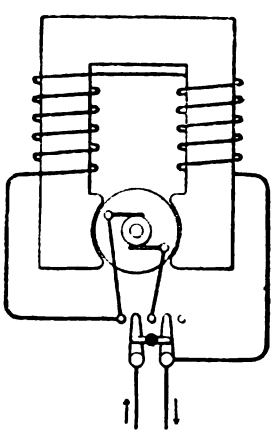

FIG. 5.—Motor with Switch for Throwing Armature and Field in Series or in Multiple Arc.

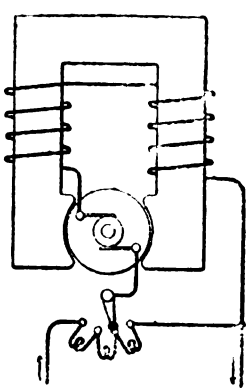

FIG. 6.—Series Motor on Variable Shunt.

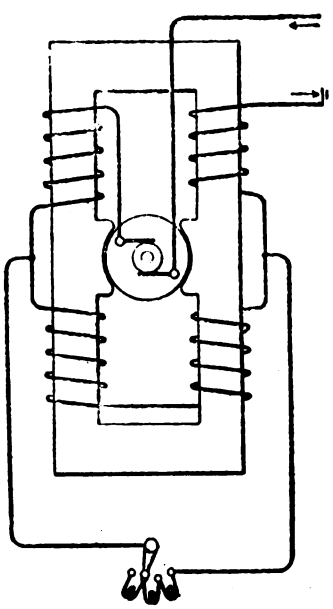

FIG. 7.—Series Motor with Variable Magnetic Shunt.

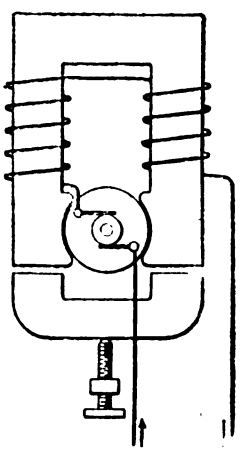

FIG. 8.—Series Motor with Variable Magnetic Short Circuit.

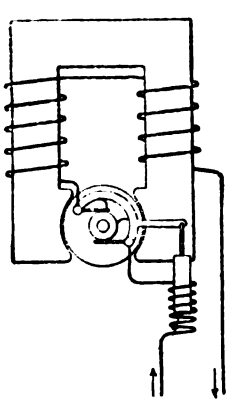

FIG. 9.—Series Motor with Automatic Device for Shifting Brushes.

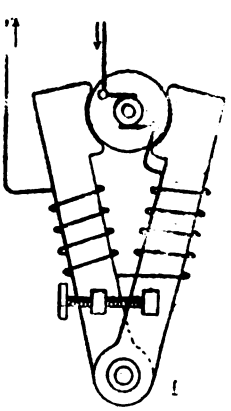

FIG. 10.—Series Motor with Device for Moving Pole Pieces Apart.

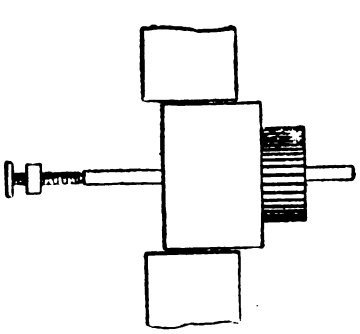

FIG. 11. - Series or Shunt Motor with Regulator for Moving Armature Out of Field.

The short-circuiting of the coils is effected by the variable shunt, as indicated.

Method 16 is very similar to the preceding, and consists in short-circuiting the field magnetism and diverting it from the armature by a keeper, which may be moved towards or away from the pole pieces by means of a screw or other contrivance.

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Methods of regulation which are all right for dynamos may not be allowable in the case of motors, because the former are usually in the hands of skilled men devoted to their care, while motors are often run by ignorant and careless persons.

Method 18, shifting the commutator, is simply another way of doing the same thing as shifting the brushes.

Method 19, shifting the magnetic resultant or direction of lines of force in the armature, may be accomplished by two sets of pole pieces, the relative magnetic strength of which is varied. This is also open to the same objection as shifting the brushes.

Method 20, shown in Fig. 10, consisting in moving or separating the pole piece from the armature, has been used in the Diehl and other motors, but it is rather difficult to carry out mechanically, and introduces a hinge or joint in the magnetic circuit, which is, of course, very undesirable.

Method 21, moving the armature away from the pole pieces, is very much easier to accomplish mechanically, and has a great many advantages as a means of regulation. Mr. S. S. Wheeler and myself have been working for some time on motors in which this method of regulation is employed, and the results we have obtained been very satisfactory; in fact, we have found it to be extremely simple, effective, and reliable.

(To be continued.)

THE BOARD OF TRADE INQUIRY.

The following is the portion of Major Marindin's report which, for the sake of economising space, we previously omitted. It may be added that, so far as we are aware, this section has not hitherto been printed in any other journal. It will be found to contain a good summary of the leading features elicited during the Inquiry :—

The cases were for convenience taken in the following order :—

I. *The London Electric Supply Corporation*, represented by Mr. Pember, Q.C., Mr. Loyd, and Mr. Graham, instructed by Messrs. Deacon, Gibson and Medcalf.—This Company having struck out several of the parishes originally included in these Orders, now seeks for powers in the following areas :—The parishes of St. Martin-in-the-Fields ; St. Margaret and St. John, Westminster (except that portion of the parish of St. Margaret, Westminster, which lies to the west of St. George, Hanover-square) ; St. James's, Westminster ; St. George, Hanover-square ; Chelsea ; part of the parish of St. Marylebone ; part of the parish of St. Pancras ; St. James and St. John (united), Clerkenwell ; the Strand District, the St. Giles District, the Holborn District, the City of London and the Libraries thereof, and the extra-parochial places of Lincoln's Inn, Gray's Inn, and the Inner and Middle Temple, all in the county of Middlesex ; the Greenwich District, in the county of Kent ; the parishes of St. Mary, Rotherhithe, and St. Mary, Bermondsey ; part of the parish of St. Mary, Lambeth ; the district of St. Olave, and the district of St. Saviour's and Christchurch, all in the county of Kent.

The following local authorities only in the above area have given their assent, viz. :—St. George (Hanover-square) Vestry, Chelsea Vestry, St. James and St. John (Clerkenwell) Vestry, St. Giles District Board, Holborn District Board.

The attitude of the remaining local authorities is as follows :—

St. Martin-in-the-Fields Vestry, Greenwich District Board, Rotherhithe Vestry, Bermondsey Vestry, St. Olave District Board, have passed resolutions of assent, subject to the insertion of certain amendments in the Order.

The City (the Commissioners of Sewers), the Strand District Board, St. Margaret and St. John (Westminster) Vestry, St. Marylebone Vestry. St. Pancras Vestry, dissent and oppose.

St. James (Westminster) Vestry, St. Mary (Lambeth) Vestry, dissent, but on terms would assent.

St. Saviour's District Board, which had assented conditionally, has withdrawn assent, but did not appear at the Inquiry to oppose.

The St. James and Pall Mall Electric Light Company, a company holding a License in the parish of St. James, is also competing and objecting to the Order of the London Corporation.

The London County Council took no part in the proceedings, but two members of the Board, Mr. A. H. Haggis and Mr. T. W. Benn, and the engineer, Mr. T. Percy Gunzon, attended on behalf of the Council.

System of Supply.

The London Electric Supply Corporation, although, as in the case of all the other companies, no particular system is specified in the Order, proposes to supply, by means of high-pressure alternating currents and transformers, with one generating station only, at Deptford, transforming or distributing stations in the different parts of the district, and transformers in the customers' houses.

The pressure in the trunk mains from Deptford will be 10,000 volts, and in the distributing mains 2,400 volts, which will be again transformed into 100 or 50 volts inside the consumers' premises.

Capital.

The capital of the Corporation is £1,250,000, the subscribed capital is £805,000 in £5 shares, and the paid up capital is £586,300, of which about £430,000 has been expended, or is committed by contracts.

The Order, as amended, contains no provision for any allocation of capital or deposit, and no clauses, except for the parish of Chelsea, requiring a compulsory laying of mains in any area (A.) or any scheduled streets, but mains are to be laid in any part of the area on requisition after a lapse of 18 months.

Price.

For purposes of charging consumers, the new unit, which is ten times as great as the present Board of Trade unit is proposed, the maximum price being "for any quantity up to 15 units £5, and for each unit over 15 units 6s. 8d. per unit," which is equal to 8d. per Board of Trade unit.

I do not here propose to deal with all the clauses of the Order, which, however, varies in many respects from what has been considered the model Order, but there are two clauses (Nos. 55 and 36) which are of a novel character.

No. 55 empowers the Corporation to supply electricity in bulk to any local authority who may under the terms of the Order borrow money on the security of the rates for this purpose, and exercise generally in their district all the powers conferred upon the undertakers, or contract with the undertakers.

No. 56 exempts the company from the strict application of the rules as to dimensions of buildings in the Metropolitan Building Act, 1855, and is intended to cover a departure from this rule in the case of their generating station at Deptford.

Objections.

The objections to the Order by local authorities are fully set forth in the record of the proceedings, and in the documents which have been lodged with the Board of Trade ; but they may be generally stated to be the experimental character of the scheme, the size of the area applied for, the insufficiency of capital, the absence of clauses providing for allocation of capital, deposit, compulsory area of supply, the safety of the public, and the removal of overhead wires, the want of proper provision for the protection of local authorities in the matter of the breaking up of streets, and the unsatisfactory nature of the clauses as to supply, and the interference with drains and the pipes of gas, water, and other companies.

The City authorities object to any company having statutory powers to break up the streets, and contend that they have power to contract for a supply.

The Strand and St. Marylebone authorities object to more than one company having powers in their districts, and to the form of the London Order and the nature of the scheme, and have entered into agreements with the Metropolitan Company.

St. Margaret and St. John (Westminster) Vestry objects to the entrance of any company in the present state of electrical science, and in the absence of any special demand for electricity.

St. Pancras Vestry, which obtained a Provisional Order in 1883, but has not acted upon it, objects because it is probable that the duty of lighting will now be undertaken by the Vestry.

It seems probable that the objections of the other local authorities can be met by the insertion of clauses.

The competing companies using the rival systems, and to some extent the Metropolitan Company, attack that of the London Company upon various grounds, which will be dealt with further on, and while the Metropolitan Company does not object to competition, the other companies urge that it is unnecessary and objectionable.

II. *The Metropolitan Electric Supply Company.*—This company having withdrawn their North London Order, now seeks for powers under three Provisional Orders and a Bill, with the following areas, viz. :—

The Mid-London Order, including the following parishes and places in the Metropolis and the County of Middlesex, viz. :—The City of London and the Liberties thereof ; and the following parishes and places in the County of Middlesex, viz. :—St. John the Evangelist, Westminster ; St. Margaret, Westminster ; St. George, Hanover-square ; St. Giles-in-the-Fields ; St. George, Bloomsbury ; St. Andrews, Holborn above Bars ; St. George the Martyr ; St. Sepulchre, Saffron-hill ; Hatton-garden ; Ely-rents and Ely-place ; the Liberty of Glasshouse-yard ; St. Anne, Soho ; St. Paul, Covent-garden ; St. John the Baptist ; Savoy, or precinct of Savoy ; St. Mary-le-Strand, St. Clement Danes, and the Liberty of the Rolls, together with the extra parochial places known as the Charter House, Gray's Inn, Lincoln's Inn, Staple Inn, Furnival's Inn, and the Close of the Collegiate Church of St. Peter.

The South London Order, including the following parishes and places in the Metropolis and in the county of Surrey, viz., St. Mary, Lambeth, Christchurch, St. Saviour's (including the Liberty of the Clink), St. Leonard's, Streatham, and Clapham.

The West London Order (as amended), including the following parishes in the Metropolis and in the county of Middlesex, viz., St. Marylebone and Paddington.

The Bill, including the parishes of St. James, Westminster, and part of St. Martin-in-the-Fields, in the county of Middlesex ; Waterloo Bridge, partly in the county of Middlesex, and partly in the county of Surrey, and the approaches thereto ; and so much of the Victoria Embankment as lies between Waterloo Bridge and the boundary of the parish of St. Martin-in-the-Fields.

The following local authorities in the above areas have signified their assent, viz. :—

In Mid-London : St. George's, Hanover-square, Vestry ; St. Giles District Board for St. Giles-in-the-Fields and St. George, Bloomsbury ; Holborn District Board for St. Andrews, St. George the Martyr, St. Sepulchre, Saffron-hill, Hatton-garden, Ely-rents, and Ely-place, and the Liberty of Glasshouse-yard ; Strand District Board for St. Anne, Soho ; St. Paul, Covent-garden, St. John the Baptist, Savoy, St. Mary-le-Strand, St. Clement Danes, Liberty of the Rolls. (Subject to special agreement).

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In South London: Nil.

In West London: St. Marylebone Vestry. (Subject to special agreement).

To the Bill: St. James, Westminster, Vestry; St. Martin-in-the-Fields Vestry.

The attitude of the remaining local authorities is as follows:—*In Mid-London:* The City; St. Margaret and St. John, Westminster. Dissent and oppose.

In South London: Lambeth Vestry; Wandsworth District Board for the parishes of Streatham and Clapham. Have withheld consent, but do not actively oppose, and would consent on terms.

St. Saviour's District Board for St. Saviour's and Christchurch, which had assented conditionally has withdrawn assent, but did not appear at the inquiry to oppose.

In West London: Paddington Vestry dissents and opposes.

The other competing electric lighting companies applying for powers (also represented as above) were:—

In Mid-London: The London, the Kensington Court, the Westminster, the Chelsea, and the Electrical Power Storage.

In South London: The London.

In West London: The London; the Electrical Power Storage.

In the Area under the Bill: The London; the Electrical Power Storage.

In this area the St. James and Pall Mall Electric Light Company, at present supplying under a License, is an objecting company.

There are other objectors to the Orders asking for insertion of clauses for their protection, as in the case of the London Order.

System of Supply.

The system proposed to be adopted by the Metropolitan Company, except at the existing station at Whitehall-place, is, as in the case of the London Company, that of high-pressure alternating currents and transformers, but it differs from the London system in details which will be referred to more particularly hereafter. It necessitates several generating stations instead of one, the sites at present selected being situated in Sardinia-street, Rathbone-place, South-mews, near Manchester-square, Eccleston-place, and Waterloo Bridge Wharf. The pressure in the mains will be 1,000 volts, which will be transformed into 100 or 50 volts inside the consumers' premises.

At Whitehall-place the direct-current system with storage batteries, now in use, will be maintained.

Capital.

The capital of the company is £500,000 in £10 shares, of which £43?,0?0 is subscribed, and £3 per share, or £131,900 in all, is paid up. There are 700 shareholders, and the company has spent, or is under obligations to spend, a sum of £351,?00.

The Orders, except as varied by the Strand and Marylebone Agreements, contain no provision for any allocation of capital or deposit, and no clauses requiring a compulsory laying of mains in any area (A) or any scheduled streets, but there is an obligation to lay mains in any part of the area on requisition after a lapse of 18 months.

In the Strand and Marylebone agreements streets have been marked upon a scaled map, in which the mains shall be laid down and completed within eighteen months after the granting of the Order.

Price.

The Metropolitan Company also proposes to adopt the new unit in place of the Board of Trade unit, and the maximum price in their Orders was "for any quantity up to 15 units £5. 10s.; for each unit over 15 units, 6s. 8d. per unit."

This price has been maintained in their South London Order, but a different scale having been agreed to for Strand District and Marylebone, the same price necessarily became that for both the Mid-London and West London Orders. It is as follows: "For any quantity up to two units 13s. 4d., and for each unit over two units 6s. 8d. per unit."

The rate per unit is not altered, and is equal to 8d. the Board of Trade unit.

In the Bill the Board of Trade unit has been adhered to, and the price is "for any quantity up to 100 units, £3. 10s.; and for each unit over 100 units, 7d. per unit."

The Orders differ in many respects from the Model Order, but contains no clauses which at this point require special mention.

The Strand and Marylebone Agreements.

The agreements entered into by this Company with the Strand and Marylebone local authorities contain provisions of an unusual character, which should be carefully considered in connection with the objections and suggestions as to clauses lodged by other local authorities before they are embodied in the Orders.

Clause 70*b*, which it is proposed to insert in the Order, stipulates that if there be any provisions in the Agreements inconsistent with those in the Order the provisions of the Agreements shall prevail.

Objections.

Paddington Vestry opposes the West London Order, because a scheme for the lighting of the parish by the Vestry is under consideration, and likely to be adopted.

Wandsworth District Board does not oppose the South London Order in principle, but asks for the insertion of clauses, the scheduling of streets in which the mains must be laid within 18 months, a reduction of price to 7d. per unit, the insertion of a provision for a sliding scale, and the incorporation into the Order of Sections 109, 110, and 111 of the Metropolis Management Act of 1855.

The objections of the City, and of other local authorities withholding consent, are of a similar character to those lodged in the case of the London Company, with the exception of the objection to the experimental nature of the scheme. These objections, other than those of the City and St. Margaret and St. John, Westminster, can probably be met by the insertion of clauses considered satisfactory by the Board of Trade.

The competing companies attack the system proposed for adoption, but not so strongly as in the case of the London Company.

The London Company does not object to the competition of the Metropolitan, and does not attack the system, but considers its own system the better of the two, inasmuch as it provides for all the manufacture of electricity being carried on outside the crowded part of the Metropolis.

III. *The House-to-House Company.*—This company applies for powers over the whole parish of St. Mary Abbotts, Kensington, with the exception of certain streets (specified in Schedule A of the Order) lying to the east of Kensington High-street Station, but it is willing to accept a district allotted by the Kensington Vestry, being the south-western portion of the parish.

The only local authority concerned is the Vestry of Kensington.

This Vestry has districted the parish among all the companies seeking for entrance, six in number, allotting certain portions to each as an Area A, and considering the remainder as an Area B, which the Vestry may call upon any of the other companies to take up.

The London and Metropolitan Companies having refused to enter on these terms, the Vestry is considering how best to deal with the two abandoned portions, those at the northern extremity of the parish.

The Vestry asks for the insertion of clauses, but will accept whatever the Board of Trade may consider reasonable.

The House-to-House Company has signified its assent to some of these clauses, and will abide by the decision of the Board of Trade, so that, as far as the Local Authority is concerned, this may be considered an agreed Order.

The other companies now promoting Orders in this parish are –

The Chelsea Company on the south-east side.

The Notting Hill Company in the west-central part of the parish.

The Kensington Court, or Kensington and Knightsbridge Company, in the east-central part.

These companies oppose *pro formâ*, and criticise the system of the House-to-House Company but only the last named asks for a revision of the area. wishing to annex two pieces out of the portion allotted to the House-to House Company.

This does not seem reasonable, except, perhaps, as regards one very small piece in Kensington High-street, in which the Kensington Court Company has laid mains.

The question should, I submit, be left for the decision of the local authorities, who seem to have gone very carefully into the matter.

System of Supply.

The House-to-House Company proposes to supply by means of the high-pressure alternating currents and transformer system, with one or more generating stations, as may be required, a pressure in the mains of 2,000 volts, and transformers in the customers' houses, where the pressure will be 50 or 100 volts.

There is a generating station now at work near West Brompton Station, at the south-west corner of the parish.

Capital.

The capital of the company is £350,000 in £5 shares, of which the sum of £41,600 is subscribed.

The Order contains no provision for any allocation of capital or deposit, and no clause rendering it compulsory to lay mains in any scheduled streets. There are the usual requisition clauses, but the period to elapse before the undertakers can be called upon to lay mains, viz., three years, is too long, and should be reduced.

Price.

This company also proposes the new unit in Schedule B relating to price, and proposes to charge under two scales.

Plan A, on the basis of a sliding scale at the rate of 10s. per unit for the first 100 units, 6s. 8d. per unit for the second 100 units, and 3s. 4d. per unit for any further quantity. These prices are equivalent to 1s. 8d. and 4d. per Board of Trade unit.

Plan B.—For any quantity up to 15 units, £5, and for every unit over 15 units, at the rate of 6s. 8d. per unit.

There is also the usual section as to charge per hours, and a section of a more novel character providing for the fixing of a standard price and sliding scale on the basis of a 10 per cent. dividend after the expiration of seven years.

It does not appear probable that the method of charging under Plan A would be an advantage to the general consumer, and the local authority objects to it.

IV. *The Notting Hill Company.*—This company schedules as the area of supply the whole parish of St. Mary Abbott, Kensington, in the county of Middlesex, although the original application to the Vestry was only for a portion of the parish, the remainder of the parish being included in accordance with the request of the Vestry.

The company accepts the portion allotted by the Vestry as the area A.

The attitude of the Vestry is similar to that taken in the case of the House-to-House Company, and the Order may be considered as an agreed Order. The objections lodged by other companies are not pressed.

The proposed method of supply is that used by the Kensington Court Company, viz., the direct supply by means of continuous currents, partly from accumulators and partly from batteries.

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No works have been erected, or, so far as the evidence goes, designed. The nominal capital of the company is £100,000, but nothing beyond the sum necessary for preliminary expenses has been subscribed.

There are no clauses in the Order providing for allocation of capital, deposit, or compulsory laying of mains, but the works necessary for supply are to be commenced within a period of four months after the commencement of the Order.

This company proposes the new unit, and proposes to charge "For any quantity up to 10 units £3. 6s. 8d., and for each unit over 10 units at the rate of 6s. 8d. per unit." This charge is equivalent to 8d. per Board of Trade unit.

Provision is also made for the fixing of a standard and sliding scale on the basis of a 12 per cent. dividend after the lapse of seven years.

V. *The Kensington and Knightsbridge Company.*—This company applies for powers over the whole parish of St. Mary Abbotts, Kensington, and so much of the parish of St. Margaret, Westminster, as lies to the west of the parish of St. George, Hanover-square.

The following are the only local authorities concerned :—

The Kensington Vestry.

The Vestry of St. Margaret and St. John.

The former Vestry has dealt with this company, which is already supplying in the parish under Licenses in the name of the Kensington Court Company, precisely as they have with the other competing companies in the parish, and the Order, so far as the allotted area in this parish is concerned, may be taken as agreed, subject to the decision of the Board of Trade in the matters of certain alterations and clauses asked for by the Vestry.

The latter Vestry dissents, and objects to the period agreed to in two Licenses, under which the company is supplying the whole of the residential area of this outlying part of the parish, being extended by a Provisional Order to 42 years.

The Notting Hill and Chelsea Companies, who are also in Kensington, do no more than oppose formally ; the House-to-House strongly opposes any invasion of the area allotted to it by the Vestry, as is proposed by the Kensington and Knightsbridge Company ; and the Metropolitan Company is competing for the whole of the portion of St. Margaret's parish included in this Order.

The system adopted by this company, and now in work at the Kensington Court Station, is the direct supply by means of continuous currents, partly from accumulators and partly from dynamos.

There is a second generating station in Chapel-street at the east end of the area, which is nearly ready for the commencement of working, and these two stations will be sufficient for the whole area.

The capital of the company is £200,000 in £5 shares, with about £38,000 paid up, and about £75,000 more promised to be subscribed.

The Order contains no clauses for allocation of capital, deposit, or compulsory laying of mains in any scheduled streets, but there is an obligation to supply under the usual terms on requisition at any time after the expiration of a period of three years.

In the schedule as to price the new unit is proposed, and the charge is as follows :—"For any quantity up to 15 units £5, and for each unit over 15 units 6s. 8d. per unit. This is equivalent to 8d. per Board of Trade unit.

VI. *The Chelsea Company.*—This company, which is supplying in the parish of Chelsea, under a Provisional Order confirmed by Parliament in 1886, is promoting two Orders, viz. :—

The South Kensington Order.

The Belgravia Order.

I. South Kensington Order.

As regards the first, the company is in a somewhat different position to the other companies in Kensington, the area allotted to it being a small portion of the parish of St. Mary Abbotts, at the east end of the parish contiguous to Chelsea, the whole of which is an Area A, with certain streets scheduled in which mains are to be laid within three years from the commencement of the Order.

This Order may be taken as an agreed Order, subject to the decision of the Board of Trade as to alterations proposed by the Vestry of Kensington.

The system proposed is the direct supply, by means of continuous currents, entirely from accumulators in several distributing stations, whence the current will be taken at a pressure of from 1,000 to 2,000 volts. In the supply mains from the distributing stations to the consumers' houses the pressure will be 100 volts.

The generating station is nearly completed, and is situated in Draycott-place, near Sloane-square.

The total capital of the company is £100,000, in £5 shares, of which £18,000 is to be appropriated for the purposes of this Order.

The total amount subscribed is about £33,000, of which about £25,300 has been expended or is contracted for. Out of the £33,000 an amount of £23,000 is subscribed by three manufacturing companies, who have contracts for carrying on the works of the company, viz., the Electrical Power Storage Company, the Anglo-American Brush Company, and Callender's Bitumen Telegraph and Waterproof Company.

It is proposed to increase the capital to £200,000, and the amount which will be expended when the full plant is at work is £108,000.

There is a clause providing for a deposit.

The provisions as to price are as follows, the Board of Trade unit being adhered to :—

"For any quantity up to 84 units, £3. 10s., and for each unit over 84 units, 8d. per unit."

II. Belgravia Order.

In the Belgravia Order the company seeks for powers over so much of the parish of St. George, Hanover-square, as is between the line formed by the eastern boundary of Chelsea parish on the west, by Knightsbridge, St. George's-place, and Hyde Park Corner on the north, and by Grosvenor-place, Upper Grosvenor-gardens, Lower Grosvenor-gardens, Buckingham Palace-road, Commercial-road, and Bridge-road on the east and south east.

There are scheduled streets within this area in which the undertakers are bound to lay distributing mains within three years. These streets comprise nearly all those in the area.

The only local authority is the Vestry of St. George, Hanover-square, which objects to the entry of the company, for the reason that permission has already been granted to three other companies, who agree to take the whole parish.

These companies, the London, the Metropolitan, and the Westminster, oppose the Order : the two first-named upon the grounds of the unsatisfactory financial position of the company, and not because they object to competition.

The capital proposed to be appropriated to the purposes of this Order is £30,000, and there is a clause providing for a deposit being made.

The system is the same as that in this company's South Kensington Order, and the provisions as to price are identical.

VII. *The Westminster Company.*—This company seeks for powers to supply in the following area, as amended, viz., part of the parish of St. Margaret and St. John the Evangelist (the outlying portion being omitted), and the Parish of St. George, Hanover-square.

The local authorities affected are the Vestries of St. George, Hanover-square, and of St. Margaret and St. John the Evangelist.

The former assents to the Order, and the latter dissents and opposes for the reason already given in the case of other companies.

The competing companies over the whole area are the London and the Metropolitan Companies, who do not object to the competition but to the financial position of the Company, and to some extent to the system of supply proposed for adoption. The Chelsea Company are a competing company in a part of the parish, and also oppose.

The system which it is proposed to adopt is that of the Kensington and Knightsbridge Company, viz., the direct supply by means of continuous currents, partly from batteries and partly from dynamos. There is a site at Victoria Mansions where the boilers and plant for 5,000 lights are nearly erected, but it is not proposed that this shall be a permanent station, and the scheme of the company does not appear to have been definitely settled.

The proposed capital is £100,000 in £5 shares, of which about £8,000 is subscribed privately.

There are only seven shareholders in the company, but subscriptions to a large amount are promised.

The Order does not contain clauses for the allocation of capital or deposit, and there is no compulsory area of supply.

The new unit for price is proposed, and charge is :—For any quantity up to 15 units, £5, and for each unit over 15 units, 6s. 8d. per unit.

VIII. *The Electrical Power Storage Company.*—This company is promoting two Orders, viz. :—

The Paddington Order ;

The St. Martin's and Strand Order.

I. The Paddington Order.

The first Order is for the whole of the parish of Paddington, divided into two areas, A and B, with scheduled streets in the former area in which mains must be laid within three years.

The only local authority, the Vestry of Paddington, opposes the Order because the supply by the Vestry itself is contemplated.

The only company competing for this parish is the Metropolitan Company, which company objects to the granting of the Order on account of the constitution of the company

The capital of the Electrical Power Storage Company is £200,000 in £5 shares, but of this sum nothing is appropriated for the purposes of this Order. The proposed capital for the undertaking is £60,000, none of which has been actually subscribed, although evidence was put in to the effect that certain large shareholders have agreed to find this sum, of which £30,000 is to be allocated to Paddington and £30,000 to St. Martin's and Strand.

No evidence was given as to the proposed system, but it would doubtless be similar to the Chelsea system.

No information was given as to the sites of proposed works, even if they have been selected.

The scale of prices is the same as that in the Chelsea Order, the old Board of Trade unit being adhered to.

In regard to the St. Martin's and Strand Order, the provisions are identical to those in the Paddington Order.

II.—The St. Martin's and Strand Order.

The local authorities are :—The Vestry of St. Martin's, which assents, and the Strand District Board of Works, which opposes, for the same reasons as are given in the case of the London Company.

The competing companies are the London and the Metropolitan Companies, both of whom strongly oppose the granting of the Order on the grounds that the Electrical Power Storage Company is seeking for powers which it is not in a position to carry out, but will have to dispose of to other parties.

London Fogs.—The Sanitary and General Purposes Committee of the London County Council have been instructed "to take into consideration the causes of the fogs which trouble London during the winter months, and the increased death rate during their prevalence, in order to put in force existing powers for dealing with them, and obtaining increased powers, if necessary."

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THE PHYSICAL SOCIETY.

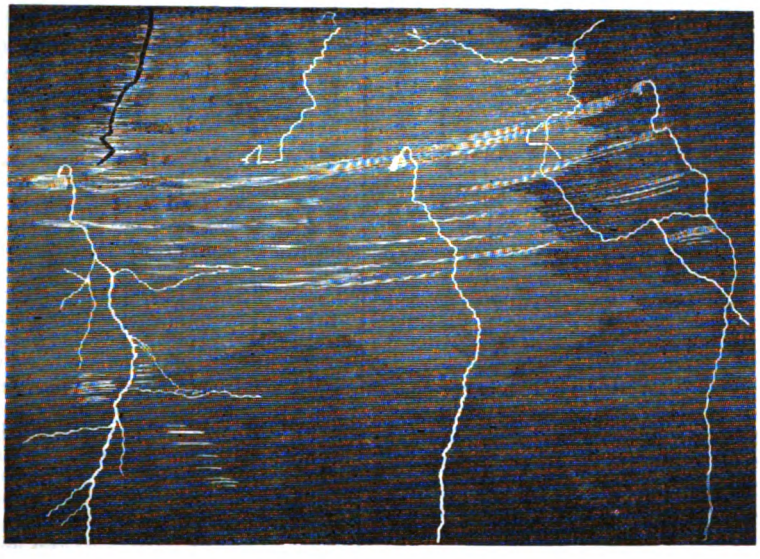
At the meeting of this Society on the 8th inst. Dr. HOFFERT exhibited

"A Photograph of a Lightning Flash"

which he had taken during the thunderstorm of the 5th inst. The photograph was taken while the camera was being waved backwards and forwards in the hands. It shows three similar parallel flashes, thus proving that successive discharges, separated by appreciable intervals of time, traversed the same path. The flash which Dr. Hoffert believes to be the primary one has numerous branches spreading out from it on each side, but the second flash has only one such branch, and the third flash has none. The space between the flashes is traversed by faint bands of light parallel to the direction of motion, appearing to indicate the existence of a residual illumination of a phosphorescent character in the intervals between the successive flashes. A dark flash crossed by similar bands of light is also shown on the negative; which disproves the explanation suggested by Mr. Whipple in a Paper recently read before the Society, viz., that the so-called dark flash was due to internal reflection in the glass negative during the process of printing.

DISCUSSION.

In the discussion which ensued Prof. A. S. HERSCHEL stated that he had taken some photographs of flashes during the same storm, and the points which he had specially remarked were the fluttering appearance of the flashes and their long duration, this being sufficient in many cases to enable him to direct the camera towards an observed flash, and obtain a photograph of it. He had not waved his camera in order to obtain evidence of multiplicity in the flashes, but in several cases he had been able by means of the naked eye to detect a series of flashes following the same path, and on moving his head from side to side he had counted as many as a dozen distinct images of what otherwise appeared to be a single discharge.



Photograph of a Lightning Flash taken with Moving Camera.

Mr. GREGORY said that he and two friends had watched the storm together, and they were scarcely ever able to agree about the shapes of the flashes or about the simple or multiplex character. He thought that the want of agreement as to the multiplicity might be due to their eyes being directed towards different parts of the sky when a multiple flash occurred, as the one who happened to be looking in the direction of the flash might only be conscious of one impression, while the others might, while turning their eyes towards it, receive several impressions on different parts of the retina. In some cases they had observed as many as three distinct flashes following the same path at intervals of about ten seconds. Many of the flashes presented a beaded or striated appearance, and the impression of the beads remained on the retina after that of the flash had faded away. This latter phenomenon might perhaps be due to the same cause as the bright bands in Dr. Hoffert's photograph.

Mr. C. V. BOYS commented on the hesitation which had been shown in accepting the statements which he had made with respect to multiple flashes during the discussion on Mr. Whipple's recent Paper, and he was convinced that no one who had watched the recent storm could continue to doubt their occurrence. He thought the best observations could be made at distances of from three to ten miles, as the observer could then see all the phenomena without the disturbance to his mental equilibrium which might arise from a dangerous proximity to the discharges.

Prof. S. P. THOMPSON thought the order of the flashes might have been the reverse of what Dr. Hoffert supposed, for the faint bands of light extended on both sides of the flash which he considered to be the primary one, whereas the outside edge of the third flash was quite dark.

Mr. E. W. SMITH stated that he had observed many cases of sympathetic discharge in which a flash in the north seemed to precipitate another in the north-west within a second or two.

Mr. C. V. BURTON thought the heating of the air by the primary flash might give rise to the branching of the succeeding ones.

Mr. A. W. WARD had been particularly impressed by the long duration of a flash which he had observed at Cambridge, and which appeared to come from the zenith, and then struck some farm buildings at a distance.

Prof. S. P. THOMPSON then read a Paper

"On the Methods of Suppressing Sparking in Electro-magnets."

The object of the Paper was to classify the methods which have been suggested for the suppression of sparks in the circuits of electro-magnets and to call attention to a novel method of some importance.

The spark which is observed when the circuit of an electro-magnet is opened, sometimes called the extra-current spark, is due to the E.M.F.s of self-induction set up principally in the coils of the electro-magnet.

The author considered only the simple case where the self-induction in the rest of the circuit is small relatively to that of the coils of the electro-magnet, and he pointed out that while the E.M.F. and integral current on closing the circuit were perfectly definite, those arising when the circuit was broken were not so, as the resistance was variable and its law was unknown. There was also the complication due to the introduction of an arc. He observed, moreover, that in large electro-magnets with solid cores the mutual induction between the coil and the mass of the core retards the rise and fall of magnetisation, and therefore distributes the E.M.F.s due to self-induction, diminishing their amplitude and retarding their phase.

Prof. THOMPSON, after pointing out that the coefficient of induction of a coil was proportional to the product of the magnetic permeability by the square of the number of turns, and was independent of the current strength, while the magnetisation was proportional to the product of the number of turns by the current strength, proceeded to classify the devices employed to prevent sparking under the heads of "Mechanical Devices" and "Electrical Devices" respectively.

MECHANICAL DEVICES.

(*a*) *Simple Snap Switch.*—The advantage of a quick-acting break was due, in the author's opinion, to the surfaces being separated by a considerable distance before the E.M.F. attained its maximum value.

(*b*) *Breaking Contact in a Magnetic Field.*—A strong magnetic field appeared to have the effect of blowing out the spark.

(*c*) *Breaking Contact under the Surface of a Liquid.*—This appeared to prevent the formation of an arc, as an example of which, the author observed, that while it was very easy to get a fairly steady arc with an E.M.F. of 50 volts between carbons held in the hands, it became exceedingly difficult to do so when they were immersed in a liquid, such, for instance, as paraffin. He was not at all clear as to the reason of this action of liquids.

(*d*) *A Wiping Break with Asbestos or Brushes.*—Here the arc seemed to be wiped out as soon as it was formed.

(*e*) *Blowing out the Arc by a Current of Air.*—This method was the one employed in the Thomson-Houston system.

ELECTRICAL DEVICES.

(*a*) *The Use of Condensers:* (1) *Across Gap*; (2) *Across Terminals of Coil.*—Condensers had the effect of lowering the potential, and therefore the striking distance, and, where their capacity was greater than $\frac{4L}{R^2}$, converted the discharge into an oscillatory one.

(*b*) *Mutual Induction Protectors.*—(1). *Copper Sheath.* This was employed by Varley in 1867 and again by Brush in 1876. (2). *Layers of Foil between the Windings.* This method was patented by Paine and Frost in 1870, and re-discovered by Prof. Arons in 1887.

(*c*) *Short-Circuit Working.*—This was well adapted for constant-current circuits, but it did not suppress the sparking due to the self-induction of the rest of the circuit.

(*d*) *Differential Winding.*—The defect of the last method was obviated by a differential winding, in which the electro-magnet was excited by breaking one of the opposing circuits, but it had the defect of requiring more copper.

(*e*) *High-Resistance Shunt* (*Non-inductive, or with R large in comparison with L*).—This method was very convenient when it was

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desired that the potential difference at the terminals should not exceed a certain value, V. Let R be the resistance of the shunt on an electro-magnet of resistance, r, with a working current, C. Let E be the maximum E.M.F. allowable. On breaking the circuit the electro-magnet and the shunt would form a closed circuit, in which the current would simply die out, and therefore V would never be greater than E, provided R did not exceed the value $\frac{E}{C}$. For example, if $r = 100$ ohms, C = ·05 ampere, E = 300 volts, then R must not exceed 6,000 ohms. The shunt might be made either of thin wire or carbon.

(*f*) *Voltameter or Liquid Resistance.*—This method, as employed by d'Arsonval, consisted in placing a set of accumulators across the break, and was fairly effective for continuous currents; but it was not perfect on account of the polarisation capacity.

(*g*) *Multiple Wire.*—This was a novel arrangement, employed by Langdon Davies in his harmonic telegraph, and consisted in winding the magnet with a number of layers of fine wire connected in parallel arc. The effect of this was to make the time-constant different for different layers, so that on breaking the circuit the energy was dissipated by mutual discharges among the different layers.

The author stated that the sparking was greatly diminished even when four layers were employed, and with twelve or more layers it was almost entirely suppressed.

(*h*) *Electro-Magnet with Two Bobbins in Series or Parallel.*

DISCUSSION.

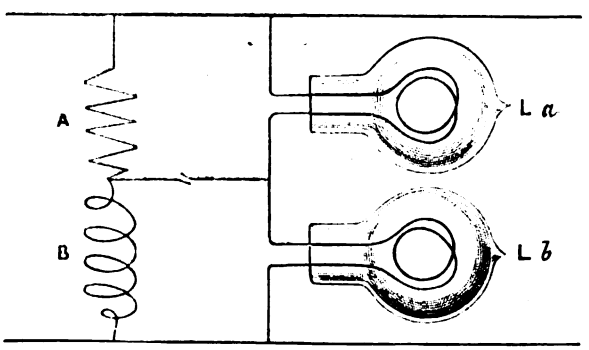
In the discussion which followed the reading of the Paper, Prof. AYRTON observed that it was important to remember that the E.M.F.s were due to the loss of magnetism, and as time was required for this to take place a quick-acting break would get beyond the sparking distance before the E.M.F. was developed. He thought the power possessed by liquids of hindering the formation of an arc might possibly be due to their cooling action. He also mentioned that Prof. Perry and himself had devised and described a non-sparking switch in which resistance was gradually introduced before breaking contact.

Prof. THOMPSON, in reply, stated that he had made a note of the switch referred to by Prof. Ayrton, but had not included it in his Paper, as in this switch the resistance of the circuit was varied in a determinate manner, and cases of this kind were outside the limits within which he had confined himself.

Mr. E. W. SMITH then read a Paper

"On a Shunt Transformer."

Suppose an alternating potential difference V to be maintained between two leads connected by a pair of resistances A and B in series. If A and B have the same impedance, then the potential



difference V_a and V_b at the terminals of A and B respectively will be equal if both the resistance and self-induction are equal in each, viz., $V_a = V_b = \frac{1}{2} V$. If, however, the resistance of A is large and non-inductive, while the self-induction of B is considerable, then V_a may still be equal to V_b, but V_a will be retarded while V_b will be accelerated.

Let the two leads be connected also by two similar sets of lamps, L_a and L_b, in series, as shown in the diagram. Then the potential difference at the terminals of each series would be $\frac{1}{2}$ V, but if the junction at the two sets is connected with the junction of the resistances A and B, the potential differences will become V_a and V^b respectively, and therefore each set of lamps will become brighter. The experiment was exhibited and the effect was very marked. The effect of joining the pair of junctions as described will be to increase the current through the inductive resistance as well as through the lamps, while diminishing the current in the main circuit.

The resistance A may consist of lamps, and B of a coil absorbing very little energy. The inductive resistance has been called by Prof. Ayrton a shunt transformer.

The author stated that he had made similar experiments with Mordey transformers, each wound with three coils, consisting of the same number of turns, one being used as the primary and the other two as independent secondaries. With one circuit comparatively non-inductive and the other inductive, the scalar sum of the amplitudes of the secondary currents was then greater than that of the primary, although the vector sum was of course less.

In conclusion the author pointed out the bearing of the experiment on the importance of devising some means of measuring the amount of energy supplied by electric lighting contractors, instead of merely the number of ampere-hours.

DISCUSSION.

In the discussion which followed the reading of the Paper Prof. S. P. THOMPSON suggested that the Paper afforded an argument against the employment of alternate currents for electric lighting.

Prof. AYRTON thought with the author that it accentuated the importance of devising some form of meter which would ensure the customers of the electric lighting companies getting what they paid for.

THE ELMORE COPPER PROCESS.

We print below an abstract of a report upon some tests of the Elmore process which were recently carried out at the works of one of the largest copper manufacturers in France under the superintendence of Mr. Stepney Rawson. The report itself, which we have had an opportunity of examining, is a very voluminous document, and bears evident traces of the care and skill which were expended to obtain accurate results. The summary, for which we are indebted to Messrs. Woodhouse and Rawson, is as follows:—

It is well known that the process consists of depositing copper, upon a rotating mandrel, from a sulphate of copper solution, but the valuable portion of the invention consists in the mechanical working of the surface of the metal from one end of the mandrel to the other by means of an agate burnisher under a few pounds pressure. By these simple means a remarkable change takes place in the constitution of the metal, which is now found to possess extraordinary strength, coupled with remarkable malleability, as may be seen from the results of the tests given below. The instruments used for arriving at the constants were a Charpentier ammeter and a Siemens potential galvanometer reading ·01 volts per degree. The dynamo was a 1 horse-power Gramme machine.

Work was carried on continuously for ten days with the exception of a short stoppage caused by an accident to the dynamo. The tubes are separated from the iron mandrels by pressure applied to the copper while the mandrel is being rotated in a lathe. The expansion of the copper is sufficient to enable the tube to slide off easily; but in regular work the method of expanding the copper by super-heated steam will be employed, as it is simpler and cheaper. The mean current used was 56·7 amperes, giving a current density of rather more than 15 amperes per square inch of cathode surface. This very high-current density is no doubt possible on account of the use of the burnisher, and is more than twice the maximum found advisable in ordinary copper refining without the burnisher.

The difference of potential across each tank was taken separately, the average being 0·9 volt per tank. In connection with this point it may be remarked that the E.M.F. does not reach its normal point until after about 36 hours; at the commencement it is about 5 per cent. higher. Connection is made with the rotating mandrel by means of a brush pressing on its surface. Notwithstanding this the steadiness of the voltmeter was practically complete, and, in fact, there appears to be an electrolytic action constantly going on between the brush and the surface of the mandrel, which tends to keep the contact remarkably perfect. The electrical horse-power absorbed in the tanks and connections amounted to 0·28 horse-power, and the total copper deposited amounted to about 104lb.

A careful calculation, deduced from the known value of the mean current, showed a close agreement between the theoretical and the actual quantity of copper deposited. The thickness of copper deposited was 0·14in., which is at the rate of very nearly $\frac{1}{8}$ of an inch per week.

Exhaustive tests were made upon portions of the tubes after their removal from the baths. The metal had a breaking strain of 32·3 and 32·7 tons per square inch, with an elongation of 7·5 and 10 per cent. on 8 inches of length in the longitudinal and transverse direction respectively. In connection with the question of elongation, it should be remarked that in ordinary practice the ductility of a metal is gauged by its elongation in the test machine. With the burnished copper the ductility is very high indeed, whilst its elongation is relatively very small, a fact which shows that we are dealing with a new variety of the metal. This point was fully

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demonstrated by Mr. W. Parker, of Lloyd's, in a Paper read before the Society of Arts, wherein he states that the ductility of burnished copper with a 13 per cent. elongation is greater than that of ordinary copper with an elongation more than three times as large.

The fracture of one piece in the testing machine was arrested the moment before it was completed, in order to display the extraordinary symmetry of the deposit; the metal begins to flow exactly at the centre, and shows almost precisely equal percentages of elongation on either side of that line. The annealed test pieces which, from the appearance of the metal, led to the conclusion that it had been overheated, gave a breaking strain of 15·4 and 14·8 tons, with an elongation of 23 and 31 per cent. on 8 inches.

It is well known that wire is made by this process, by taking a deposited tube and shearing off a continuous square strip, beginning at one end and continuing until the whole of the tube has been cut into one continuous length of copper strip. This does away with the numerous processes of re-melting, casting, and sawing up, by which all high conductivity wire is made.

Portions of the tube were drawn down from a thickness of 3·4 millimetres to 1 millimetre through 14 hard holes without annealing, instead of having to be annealed every few holes. A test of this wire gave a breaking strain of 35 tons per square inch. Another sample of the same diameter was annealed and then drawn through 15 hard holes to a diameter of 0·98 millimetres, giving a breaking strain of 32·4 tons per square inch. A portion of this wire annealed and drawn through 7 holes to a diameter of 0·53 millimetres, and then annealed again, gave a breaking strain of 20·4 tons per square inch, with an elongation of 35 per cent. on 4 inches of length. Another portion of the tube was annealed and rolled cold from 3·5 millimetres to 1millimetre thickness, and gave when finished 26 tons per square inch breaking strain.

In both the wire drawing and the rolling the metal showed very exceptional qualities as regards ductility, and the above figures are sufficient evidence of its extraordinary strength. In addition to this, however, some interesting experiments were made of its behaviour under the hammer. At first the opinion of the workman employed to make these tests was that nothing could be done with the metal on account of its hardness. In spite of this he was however perfectly successful in hammering a broad flange 2½in. in width, on the edge of which he hammered out a tongue ·012in., or less than $\frac{1}{10}$th of the ordinary thickness of the tube, without the slightest sign of a crack in the metal. The extraordinary quality of the metal was plainly observable by the way in which the workman showed his hesitation in going any farther with the test, and his final opinion openly expressed was that it was impossible to break it under the hammer.

Several other exceptional tests were made, all of which were successfully withstood. It is impossible to give any exact idea of the value of these tests to those unacquainted with the nature of copper working, but it may be remarked that the single fact of the possibility of hammering a flange in the tube of this metal without once annealing places it in an entirely different category to any other class of tubes in which the annealing necessary to enable the tube to be worked robs the metal of a large percentage of its strength, whereas the burnished metal remains unimpaired at the very point where strength is principally required.

In one respect the copper showed a very remarkable difference from the ordinary metal. There is a growing tendency among engineers to regard the elastic limit of the metal as the real test of its commercial value in the matter of withstanding strains. In this respect the burnished metal shows a very high result, the ratio of elastic limit to breaking strain being as high as 61 per cent., and an English test on a similar tube gave a figure as high as 82 per cent. There are many indications that the limit of the reduction of horse-power necessary for producing a given weight of copper has not yet been reached, but an inspection of the above figures will show what a small amount of motive-power is required to produce a ton of copper in the form of finished tubes. The tests were carried out in the works of one of the largest copper producers in the world, and therefore ample opportunities occurred for comparing the new type of metal with the ordinary type, and it was plain that in every respect the superiority of the new was fully recognised by men thoroughly capable of judging.

Electrical Production of Bleaching Powder.—The *Gas World* says that Mr. Charles Lever, of Altrincham, has succeeded in producing direct from natural brine, by means of electricity, bleaching powder, caustic soda, and a solution to be used in bleaching the finest and most delicate fabrics. This discovery is likely to have the effect of revolutionising the manufacture of bleaching powder and the bleaching industry generally.

TARIFF OF THE STANDARDISING LABORATORY AT GRENELLE.

The following is the tariff adopted by the Commissioners of the Standardising Laboratory at Grenelle:—

A. Tests resulting in a certificate.

5fr.—(1) Conductivity per kilometre of a metallic wire. (2) Conductivity of an electric light carbon.

10fr.—(1) Insulation resistance of a dielectric. (2) Constants of a metallic wire (diameter, conductivity, mechanical strength, flexibility). (3) Standardising commercial ammeters, voltmeters, electro-dynamometers, or any kind of galvanometer. (4) Constants of a condenser (capacity, insulation). (5) Standardising a standard cell (E.M.F. at a certain temperature). (6) Photometric intensity of an incandescent lamp in several azimuths. (7) Photometric intensity of a gas flame or other similar source of light. (8) Standardising a resistance at a certain temperature.

20fr.—(1) Insulation tests under various conditions. (2) Photometric intensity of an arc in various azimuths. (3) Electric light carbon tests (conductivity, fixity of arc, rate of consumption). (4) Test of a formed accumulator (E.M.F., capacity, curve of discharge). (5) Battery tests (variation of E.M.F. and of resistance under working conditions).

25fr.—(1) Standardising an "electricity counter" for continuous currents. (2) Standardising a resistance box at a certain temperature. (3) Cable tests (conductivity, capacity, insulation after 24 hours' immersion in a bath at 24°C.). (4) Test of a dynamo of 1 horse-power and under (E.M.F., resistance and characteristic curve).

50fr.—(1) Standardising a laboratory ammeter or voltmeter. (2) Testing a standard resistance (resistance and variation with temperature). (3) Testing a standard E.M.F. (E.M.F. and variation with temperature). (4) Tests of 1 to 10 horse-power dynamos.

100fr.—(1) Tests of 10 to 15 horse-power dynamos.

B. Tests made according to the directions and in the presence of the person concerned, and which do not result in a certificate.

	Half-day (1 to 4).		Whole day (4 to 8).
Tests without dynamo or accumulators	...10fr.	.....	15fr.
Tests with dynamo or accumulators	.....15fr.	.....	25fr.

C. Tests at reduced charges.

(*a*) Standardising sets of identical commercial ammeters or voltmeters: in sets of 5=25fr. the set; in sets of 10=45fr. the set.

(*b*) Standardising sets of identical "counters": in sets of 5=50fr. the set: in sets of 10=75fr. the set.

(*c*) Cable tests; a set of 4=50fr. the set.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June* 1, 1889.

We are now awaiting the decision of the United States Circuit Court at Pittsburg in the lamp suit of the Westinghouse Company against the Edison Company. In this case the Westinghouse Company, as assignee for the Consolidated Company, has brought action against one of the sub-companies in the Edison ranks for infringement of the Sawyer-Man patent on the carbon filament, made from fibrous or vegetable material. It is claimed, and was argued last week before the court, that the Sawyer-Man lamp, embodying such a filament in an "arch" shape, was perfected in March, 1878, and that the same result was not arrived at by Edison until 1879. The Edison plea to the contrary was that Edison began experimenting on the subject in 1877, prior to the professed invention of Sawyer and Man, and made use in his experiments of carbonised paper among numerous other things. He subsequently conducted an extended series of experiments with platinum wire and other materials for conductors, and was convinced from the beginning that carbon of some form, fibrous or otherwise, was the most desirable material for an incandescent conductor in a sealed globe, provided that the chamber had been so exhausted

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as to maintain a stable vacuum. Edison finally achieved his well-known results, it is claimed, in the fall of 1879, and exhibited his lamp at Menlo Park, where he used a lamp such as is now employed everywhere, in which the filamental carbon, having high resistance to the passage of the electric current, is secured in a glass globe sealed up by fusion of the glass from which the air had been exhausted to a state of high vacuum. To obtain this result, moreover, he had followed the method of operating the lamps in parallel, whereas Sawyer and Man sought to use low-resistance filaments, involving a resort to the series method. Mr. Edison finally settled down to bamboo fibre, as the result of experiments which cost hundreds of thousands of dollars, and which he ultimately selected after sending agents all over the world to get bamboo of just the necessary structure. While the original Edison lamp was thus publicly exhibited at Menlo Park to everybody, the original Sawyer-Man lamp was shown to nobody, and such lamps as were subsequently shown were practically worthless. To this was replied, that although Mr. Edison had been credited with the invention of the entire incandescent lighting system in vogue to-day, that system did not become practicable until after Sawyer and Man had discovered the suitable fibre. The statement that the Sawyer-Man lamp would not burn was incorrect, as it had been fully tested and found to burn for 150 hours. After the Court had heard the arguments it took the papers and reserved its decision. One of the particular claims in the Sawyer-Man patent on which the suit is based is for "an incandescing conductor for the electric lamp of carbonised fibrous or textile material, and of an arch or horseshoe shape, substantially as hereinbefore set forth." It will be observed that this is a very broad claim, and that it covers the essential features of the Edison lamp. A similar suit has been going on before the Circuit Court in New York, bringing out the same evidence as has been adduced in the Pittsburg suit, and rehearsing facts which have now become an old and worn story to everyone acquainted with the subject of incandescent lighting and the litigation of it. The importance of this suit at Pittsburg is that it apparently brings the matter nearer to a final adjudication than it has ever before reached in this country; but it is understood that whichever way the case goes the losing parties will immediately appeal to the United States Supreme Court.

That we are gradually improving in our methods of indoor wiring may be inferred from the statements which have just been made by Inspector M'Devitt of work done in the city of Philadelphia. Mr. M'Devitt has the supervision of electrical construction there, and his report for last year shows that the element of danger has practically disappeared. He says that during the past year not a single dollar has been paid for damage by fire caused by electricity, in spite of the fact that the section of which he writes embraces over 1,300 houses which are using current. Some of these buildings, moreover, have been wired for upwards of eight years, a fact which certainly speaks well for the construction and the subsequent inspection at the time. A report of equally encouraging nature comes at the same time from Chicago, where last year a total of 2,369 arc lamps and 17,717 incandescents was inspected, which, added to 22,756 lamps inspected during the previous year, made a total to January 1st, 1889, of 42,842 lights. The report states that during the year a marked disposition to improve the standard of installations has been manifested, and, as an evidence of the feeling on the subject, it is added that at a conference held recently to consult on the subject an unqualified condemnation of the cheaper insulations, especially that known as "underwriter's," was unanimously expressed by the representatives of all the principal companies doing an arc and incandescent business in Chicago It is interesting to note also that at the beginning of the year there were 53 motors in use in Chicago, ranging from $\frac{1}{8}$ to 15 horse-power,

The Bill for increasing the American Bell Telephone Stock from $10,000,000 to $20,000,000 has now been passed in the Massachusetts House and Senate, and the company will therefore be well provided with funds for carrying out some of the larger schemes which it has in contemplation, such as the erection of its new building in Boston and the extension of its long-distance telephone service in the West. As might be expected, the company encountered some opposition in this matter, but by no means so much as they experienced before when a similar move was undertaken. The company will have no difficulty whatever in selling such of the stock as it may choose to put on the market. The present price of Bell Telephone Stock is about 240, which is sufficient to show that there will be an eager demand for all that may be placed within the public reach. Although Bell Telephone Stock is regularly quoted, and there is a more or less active market in it, it does not appear that at any time a very large number of shares exchange hands now.

CORRESPONDENCE.

THE TERMINOLOGY OF ALTERNATING CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is much to be hoped that the confusion from which acoustics and optics have recently escaped is not about to settle upon electricity. In the former sciences "period," or "wave," refers always to the complete cycle of changes; and the number of complete periods in the unit of time, say, one second, is (after Thomas Young) called the "frequency." The same terminology is applicable to electrical vibrations. The period, or periodic time, will of course cover one positive and one negative part; and in like manner the "periodic frequency" will mean the number of periods per second. When the usage is well established, it may be possible to drop the qualifying "periodic," and to speak simply of frequency; but in electricity there may be at first some danger lest the frequency of alternating currents should be taken to mean the frequency of *alternation*. For this reason it will be prudent for the present to speak always of *periodic frequency*.—Yours, &c.,

RAYLEIGH.
WILLIAM THOMSON.

Terling-place, Witham, Essex, June 11, 1889.

SELF-INDUCTION IN ALTERNATING-CURRENT MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your leaderette in your last issue you regret that Dr. Hopkinson did not bring his discovery forward sooner, and mention Mr. Kapp and Prof. Forbes' names as being identified with the theory that alternate motors depend on self-induction. May I offer a slight correction. Dr. Hopkinson devoted the larger part of a Paper at the Society of Telegraph Engineers to the investigation of the effect of self-induction in making machines synchronise.

His Paper is painfully mathematical. The action of self-induction was explained in English by me in some articles on Electrical Measurement in 1887, and I certainly regarded the theory as well known then. I may add that I see nothing in Mr. Mordey's interesting experiments which conflicts with the recognised theory; in fact, the position of synchronous motors is not altered, and the strictures in my articles on testing alternating dynamos and motors seem to me still to hold good.—Yours, &c.,

JAS. SWINBURNE.

Wimbledon, June 11, 1889.

[Our correspondent has slightly misunderstood the purport of our note. The position which we were attempting to elucidate appears to us to be this: (1) Prof. Forbes and Mr. Kapp have recently insisted upon the supreme importance of the presence of self-induction in the working of alternators in parallel. (2) Mr. Mordey has shown that very little self-induction—apparently much less than that demanded by Mr. Kapp—is necessary. (3) In 1884, however, Dr. Hopkinson gave a well-nigh complete solution of the problem, with expressions from which the best value of L in a given case might readily be deduced. We regret that we are not well acquainted with Mr. Swinburne's work of 1887 in this particular direction—the greater part of his valuable book we know well—but we shall take the earliest opportunity of remedying this deficiency. —ED. *E.*]

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

May 21, 1889.

8,390. W. M. MORDEY. London. Improvements in electric motors.

8,400. J. M. PORTER. Leeds. An improvement in electric bells.

8,451. G. GALLOP. London. Improvements in conduits for electric light and other wires.

8,453. W. M. MORDEY. London. Improvements in regulating electric currents.

8,456. L. BRISTOL. London. Improvements in portable electric safety lamps.

8,459. T. L. WILLSON. London. Improvements in dynamo electric machines and electric motors.

8,460. G. FR..NCE and E. HOLROYD. London. Improvements in coating and protecting wires for electrical, telephonic, and other analogous purposes; also applicable in the manufacture of tubing.

8,468. T. D. HOLLICK. London. Improvements in tramcars, locomotives, or other vehicles driven by electricity.

May 22, 1889.

8,493. W. J. S. BARBER-STARKEY. Manchester. Improvements in automatic cut-outs for electric circuits.

8,528. J. HOPKINSON. London. Transmission of power by alternate electric currents and apparatus therefor.

May 23, 1889.

8,557. M. PARKER. London. Improvements in or relating to meters or instruments for measuring currents of electricity.

8,559. W. OSBORNE and J. S. SCALES. Tonbridge. Improvements in securing telegraph wires to insulators.

8,588. J. SWINBURNE. Wimbledon. Improvements in alternating-current dynamos and motors.

8,606. M. BAILEY and J. WARNER. London. An improved form of secondary battery for the use of miners and the like, and lamp mount for same.

8,619. A. SIEGMANN. London. An improved electrical alarm for audibly indicating and announcing the varying water levels of steam boilers and the like.

May 24, 1889.

8,631. R. THOMPSON and H. J. PYNE. Liverpool. An improved portable electric lamp and battery.

8,657. E. B. BRIGHT, F. W. ENGLEBACH, and J. B. BRIGHT. London. Improved methods and appliances for conducting and distributing electric currents.

8,674. J. HOPKINSON. London. Improvements in connection with electrical tramways or railways.

8,692. J. E. KINGSBURY. London. Improvements in multiple switch board systems for telephonic exchanges and wire bands to be used therein (The Western Electric Company, United States).

May 27, 1889.

8,697. S. H. GIBSON. London. Improvements in electric musical mechanism.

8,709. E. H. M. ANDREOLI. Brixton. Amalgamating gold by electricity and mechanical motion.

8,730. A. M. CLARK. London. Improvements in printing telegraphs (W. F. Johnson, United States).

8,769. A. C. COCKBURN and J. N. COOPER. London. Improvements in electrical measuring instruments.

8,780. E. M. DE FACIEN. London. Improvements in electrical switches.

8,793. W. H. WINNALL. London. Improvements relating to screw-cutting lathes and to electrical indicating apparatus for use in connection therewith.

8,800. H. H. LAKE. London. Improvements in regulators, chiefly designed for use in electric arc lamps (O. H. L. Lindemann, Germany).

May 28, 1889.

8,815. W. P. THOMPSON. Liverpool. Improvements in devices for automatically interrupting an electric circuit under pre-determined conditions (The Westinghouse Electric Company, United States).

8,855. T. HARRIS and H. F. DE B. CAMERON. United States. Improvements in secondary batteries or accumulators.

May 29, 1889.

8,905. A. G. BURRELL. Sheffield. Receiving and transmitting an electric current for telephonic, telegraphic, or other electrical purposes, viz., "The anti-alternate current relay."

8,925. C. WELLS. London. Improvements in electric batteries.

8,935. A. CASSERINI. London. For an invention for electricity employed as agent for destroying rabbits and other animals prejudicial to agriculture.

8,944. D. C. BATE. Dulwich. Improvements in electrical switches or commutators.

8 958. A. FRAGER. London. An electric meter.

May 30, 1889.

8,973. F. BOSSHARDT. Manchester. Improvements in the method of and means for collecting and storing electrical energy (V. Hoeft and Co. and R. F. Verdier, Belgium).

8,979. F. V. ANDERSEN. London. Improvements in electric switches.

8,986. D. URQUHARDT, W. BATES and F. WYNNE. London. Improvements in secondary batteries.

8,999. J. HOPKINSON. London. Improvements in electrical tramways or railways and apparatus therefor.

May 31, 1889.

9,034. W. PRESSLAND and W. T. PRESSLAND. London. Improvements in self-contained dome electric bells.

9,074. R. WARWICK. London. Improvements in the electric ignition of gas.

June 1, 1889.

9,093. A. JUNG. Liverpool. Improvements in storage batteries.

9,096. H. F. JACKSON and D. SINCLAIR. Glasgow. Improvements in telephonic switch-boards.

9,119. E. F. FIFORD. London. Improvements in electric bells.

9,133. H. H. LAKE. London. Improvements in the manufacture of carbons or electrodes for electric lamps (Lacombe and Co., France).

June 3, 1889.

9,153. D. J. ARNOLD and H. B. CORYELL. London. An improved dry galvanic battery.

9,162. C. E. L. BROWN. London. Improvements in the armatures of dynamo machines.

9,163. L. B. MILLER. London. Improvements in electricity meters or apparatus for measuring electricity, partly applicable for other purposes.

9,166. D. WELLS. Edinburgh. An improved electrical repeater and commutator to indicate the normal position and the movements of railway or other signals, slots or the like.

9,182. A. GRAHAM. London. Improvements in apparatus or devices for switching or diverting electric currents, more especially intended for use with telephonic circuits.

9,183. M. SUSSMANN. London. An improved exciting liquid for electric batteries.

9,192. W. W. STRODE and W. DAVIS. London. A new or improved fitting for electroliers.

9197. H. SUBLINER. London. Improvements in and relating to relays for telegraphic purposes.

June 4, 1889.

9,231. W. E. HEYS. Manchester. Improvements in the method of and devices for regulating currents generated by shunt-wound dynamo-electric machines (E. P. Clark, United States.)

9,237. G. E. DORMAN. Stafford. Improvements in dynamo-electric generators and motors.

9,238. R. H. COURTENAY. London. Improvements in micro-telephonic apparatus.

9,241. A. A. C. SWINTON. London. Electric meters.

9,258. F. L. RAWSON and W. S. RAWSON. London. Improvements in electric signal lamps and appliances connected therewith.

9,294. H. H. LAKE. London. Improvements in and relating to dynamo-electric machines and electric motors (C. S. Bradley, United States).

9,300. H. H. LAKE. London. Improvements in and relating to dynamo-electric machines (H. Lemp, United States).

9,304. W. BARNICOAT. London. Improvements in switches for electrical purposes.

June 5, 1889.

9,350. J. JOHNSON and F. RUSSELL. London. Improvements in dynamo-electric machinery.

9,352. F. ESPIR (agent for P. Klotz). London. Improvements in electrical horology (L. Belzon Fils, France).

9,376. H. J. HARRIS. London. Improvements in miners' electric lamps.

June 6, 1889.

9,397. H. W. C. COX. London. Improvements in electrical thief detectors.

June 7, 1889.

9,440. E. W. J. MACDONALD. London. Improvements in ceiling roses for suspending electric lamps and other electrical purposes.

9,445. J. W. SEE. London. Lightning arresters for electric conductors.

9,456. B. M. DRAKE and J. M. GORHAM. London. Improved method for preventing fumes from secondary batteries.

9,461. D. MCINTOSH REID. London. Improved composite electric omnibus.

9,496. F. MARX. London. Improvements in the accumulation of electrical energy and apparatus therefor.

June 8, 1889.

9,508. E. A. SPERRY. London. Improvements in arc lamps and in dynamos to be used therewith.

9,509. E. A. SPERRY. London. Improvements connected with electrically operated coal-mining and drilling machines.

9,528. H. COLES. London. An improvement in telephony.

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SPECIFICATIONS PUBLISHED.

1888.

6,893. WALKER. Electro-generators. (Price 8d.)
6,985. IMMISCH. Electrical tramcars. (Price 11d.)
9,032. MORTIMER and HOLLOWAY. Electric arc lamps. (Price 8d.)
9,046. COX-WALKER and SWINTON. Magneto-electric bells. (Price 8d.)
9,817. KAPP and others. Transformers. (Price 8d.)
9,825. MACKIE. Electrical switches. (Price 8d.)
9,907. DELIVO DOBROWOLSKY and others. Electric current and tension meters. (Price 8d.)
9,910. KAPP. Dynamo-electric machines. (Price 8d.)
10,048. DRAKE and GORHAM. Switching accumulators. (Price 8d.)
10,782. MILLER. Electric meter. (Price 8d.)
10,887. DAY. Electric cartridges, &c. (Price 11d.)
11,544. CUMMING. Electrical coin-freed machines. (Price 1s. 1d.)
18,220. BATAULT. Electricity meters. (Price 8d.)
18,494. ROBERTS and BREVOORT. Galvanic batteries, &c. (Price 8d.)
19,061. CORNWELL. Galvanic batteries. (Price 6d.)

1889.

5,142. CURRIE. Electrical distribution. (Price 8d.)
5,176. SPERRY. Electrical installations. (Price 8d.)
5,293. HICKS. Distributing, &c., electric currents. (Price 6d.)
5,621. LAKE (Thompson). Electric induction coils. (Price 8d.)
5,913. VAN DEPOELE. Electric railways. (Price 8d.)
6,112. NEWTON (Main). Secondary batteries. (Price 8d.)
6,119. SHEDLOCK and MESTERN. Thermo-electric batteries. (Price 8d.)
6,423. JARMAN. Electrical motors. (Price 8d.)
6,527. LAKE (Tesla). Electro-motors. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Lancashire and Cheshire Telephonic Exchange Company (Limited).

The eighth ordinary general meeting of the shareholders of this Company was held on Tuesday last at the Memorial Hall, Manchester, Mr. Alderman Joseph Thompson, Chairman of the Directors, presiding.

The Directors' report and statement of accounts, already published, were taken as read.

The CHAIRMAN moved their adoption and the declaration of a dividend at the rate of 8½ per cent. per annum for the ten months ending 30th April. This, he said, was the largest dividend the Company had ever declared, and it was the largest the Company had ever made.

The motion was seconded by Mr. ELI HEYWORTH (Blackburn), Deputy-Chairman of the Company, and adopted.

The meeting was then made an extraordinary general meeting, for the purpose of submitting the following resolutions for confirmation:—

(1) "*That the Agreement submitted to this meeting, and expressed to be made between this Company and the National Telephone Company (Limited), for the Amalgamation of the two Companies, by a transfer of the business and property of this Company (with certain exceptions) to the National Telephone Company (Limited), in consideration of shares in that Company be, and the same is, hereby approved.*"

(2) "*That with the view of giving effect to the above-mentioned Agreement, and in order to enable the shares to be allotted thereunder to be distributed among the members of this Company, this Company be wound up voluntarily, under the Companies' Acts, and that Thomas Abercrombie Welton be, and he is hereby, appointed liquidator for the purpose of winding up its affairs and distributing its property.*"

(3) "*That pursuant to the 161st section of the Companies' Act, 1862, the liquidator be, and he is hereby, authorised to carry the said Agreement into effect, and to receive the shares agreed to be allotted thereunder, and to distribute the same in specie among the members of this Company.*"

The CHAIRMAN said there was an old saying that union was strength, and the Lancashire and Cheshire Company, and the other telephone companies of the kingdom, had for some time back felt that they would be in every way much better off if they were to be united on equitable terms. The Directors had come to the conclusion, after very careful thought, that in every way it would be advantageous to the Lancashire and Cheshire Company to amalgamate with the other two companies—the United Company (the parent company) and the National Company. They thought the amalgamation would result in the reduction of the working expenses by a very considerable amount. In the second place, they thought there would be the advantage of having the opinion of skilled persons who had given their thought to telephonic development, and who represented different portions of the country; and they thought that by amalgamation they could work together profitably as one board. Then they thought the adoption of the proposal would result in developing the telephonic system very largely indeed. Their Company had already an extensive trunk system in the two counties, and the Directors believed that with the march of science the time was not far distant when telephonic messages might be easily sent to great distances. It would be manifestly advantageous for the Stock Exchanges of our great centres of population to be put in telephonic communication one with another. Then the shareholders had also to look at the matter as one of self-interest. The intention of the three companies in their union was to have formed a new company, and this new company was to buy up the three existing companies, and probably by-and-bye to buy up the subsidiary companies. Everything was arranged between the three companies, but at the last moment the Postmaster-General declined to grant a license to the new company. Before he went further perhaps he might say that they had spent twelve months in trying to come to a basis of agreement. It was thought at first that the best way would be to submit the books of the three companies to a first-class firm of accountants, and in that way ascertain on what terms each company should be taken in. But after twelve months of labour they found that they were no further forward than they were before, and the Directors began to think whether there was not a better way. Mr. Charles Agnew, one of the Directors, suggested that the fairest and simplest way would be to take the market value of the different stocks on a certain date. That idea was also broached in London, and it was ultimately adopted. But when everything had been arranged on this basis the Postmaster-General was approached, and was asked if he would grant a new license. This he distinctly refused to do, and for a time it appeared as if they were to be baffled in their efforts. But the solicitors looked into the matter and found that there was full power for any one of the existing companies to absorb the other two, and the company which was thought to be the most suitable to do so was the National Company. That company had a good name, and it covered the whole country. It was also in favour of that company absorbing the other two that the par value of its shares was £5, and the market value only £6, whereas if the United Company had been taken as a standard, their shares, which stood in the market at £15, would have had to be reduced to £5, because £5 was the nominal value. The nominal value of the Lancashire and Cheshire Company's shares being only £1, they were, for the purpose of which he was speaking, in a worse position

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than either of the other two. It had since been arranged that the agreement should be so far modified that the market value of the shares should be reduced by one-sixth—that the United Company's should be taken at £12. 10s., the National Company's at £5, and that the Lancashire and Cheshire Company's, which stood in the market at £1. 11s. 4d., should be reduced to £1. 6s. 3d. Although that seemed to be a reduction in the value of the shareholders' property, it was not so in reality. Although it decreased the nominal amount, it increased the dividend on the shares, and the moment it was known on the market that the shares were earning a larger dividend they would go up to the old value. Therefore, when it was suggested that the value of the share should be reduced to £1s. 6s. 3d. it was only a nominal matter, and they would get the full value of their shares if they wished to sell. He had no doubt they had seen that the Postmaster-General had expressed dissatisfaction with the action of the companies in this matter. It would almost seem as if they existed on sufferance from the Post Office. The Postmaster-General would not allow them to transmit the cotton market from Manchester to Liverpool, and he would not allow their athletic friends to telephone the result of a cricket match from Old Trafford to Manchester, because to do that was to transmit news, and the Post Office derived a certain revenue from that source. But surely that was, after all, crippling a legitimate business. The telephone companies did not exist on sufferance from the Post Office, which did nothing to develop their business. It only gave them a license to work, and for that it exacted from them a large royalty. He found that the three companies about to be amalgamated paid to Her Majesty's Post Office £35,000 a year in royalties for which the Post Office did nothing at all except to send their clerks to examine the telephone companies' books to see that the companies did not cheat. In return for what they contributed to the revenue they had got a letter from the Postmaster-General saying that he disapproved of the scheme. The companies, after all their trouble and outlay, were entitled to fair consideration, and ought not to be treated in the manner they had been. The *Economist* of June the 8th spoke of the scheme of amalgamation as one directly hostile to the public interests, but the promoters of the amalgamation maintained on the contrary that it would be advantageous to the public. As a trading company, their property depended on how the public were satisfied with the manner in which they served them. He did not hesitate to say that by amalgamation they would have a larger capital at their command to develop their business, and their endeavour would be to serve the public as well in the future as in the past. A number of their patents would soon lapse, and competition might be started, and it behoved them to set their house in order, so that when the patents lapsed the public might not want to go to some other company. Let it be remembered that they were liable to competition at any time. There was nothing to prevent any other company starting provided they could get a license from the Post Office. Under amalgamation they would not have so much to fear from competition. He thought they would be able to reduce their charges by-and-bye, and to render the public more efficient service in the future than they had done in the past. Certainly it was the wish of the Directors to make the service as cheap and efficient as they possibly could. He concluded by moving the adoption of the resolutions as given above.

Mr. ELI HEYWORTH seconded.

In reply to a question by Mr. EDWARD CROSS, the CHAIRMAN said the Company's license did not lapse till the year 1912. So long as they did not break its provisions in any way, and they would be most careful not to do that, the license could not be withdrawn. The amalgamated company would have a right to go into any part of the kingdom.

Mr. J. E. LONGSON supported the motion for the adoption of the report. The Directors, he said, were deserving of great credit and the thanks of the shareholders for the efforts they had made to bring about this scheme of amalgamation.

Mr. JOSHUA OPENSHAW asked what it was proposed to do with reference to the position taken up by the Postmaster-General.

The CHAIRMAN said that in the action they had taken they had been fortified by the advice of three of the best counsel on the subject of public companies. He had no fear whatever as to the action of the Postmaster-General on the major question, although in minor matters there might be vexatious interference. If there was such interference they could enlist the services of the local members of Parliament, and get the matter brought before Parliament.

In reply to further questions, the CHAIRMAN said it was understood that in addition to the Central Board there would be local Boards of Directors. One advantage of amalgamation was that there would be more money at disposal. The Directors of the Lancashire and Cheshire Company had had a great deal of trouble and anxiety as to finances, not from the untrustworthiness of the Company, but quite the contrary. They had increased their business, and they saw a large increase in the future; but where was the money to come from? They could not issue another share without the consent of the United Company, who had them in their grasp. Any shareholders who did not wish to continue to hold the shares after amalgamation would receive the market price of their shares.

The motion was then put to the meeting and adopted.

A vote of thanks to the Directors brought the proceedings to a close.

NEW COMPANIES REGISTERED.

ELMORE'S FOREIGN AND COLONIAL PATENT COPPER DEPOSITING SYNDICATE (LIMITED).—The prospectus of Elmore's Foreign and Colonial Patent Copper Depositing Syndicate (Limited) states that this company has been formed to acquire the foreign patent rights relating to the extremely valuable discovery made by Messrs. Francis Edward Elmore and Alexander Stanley Elmore for manufacturing copper articles direct from rough copper bars, which does away with the processes of melting, rolling, forging, drawing, &c., and the present costly and laborious methods of manufacturing copper articles, such as tubes, vats, cylinders, pans, printing rollers, wire for electric purposes, and a vast number of other articles too numerous to mention. The capital of the company is £120,000, divided into 15,000 priority shares of £5 each, and 9,000 founders' shares of £5 each. Of the above, 3,250 priority shares and 650 founders' shares have already been applied for by the directors and their friends, and will be allotted in full; 11,750 priority shares and 2,350 founders' shares are now offered for subscription. The shares are payable:—10s. on application, £1. 10s. on allotment, £1. 10s. on the 1st. August, 1889, and £1. 10s. on the 1st October, 1889. The 3,000 founders' shares are reserved for allotment exclusively amongst applicants for priority shares, in the proportion of one founders' share for every five priority shares allotted, and the remaining 6,000 founders' shares will be allotted to the vendors. The Directors are—Sir John H. Morris, K.C.S.I., Edward J. Carson, Esq., John Macfarlan, Esq., J. Jephson Atkinson, Esq., John T. Cooper, Esq., Frederick L. Rawson, Esq., M.I.E.E., and William Elmore, Esq. It is not intended that the present Company should work the process, but that it should resell the patents by the formation of subsidiary companies for different countries, and negotiations have already been commenced with a view of selling the patents for all foreign and colonial countries to one group, on terms which point to the shares of this Company receiving quite unusual returns at a comparatively early date. The price paid for the English patents was £100,000 in cash and shares. The amount to be paid by the company is £110,000, of which £30,000 is payable in Founders' Shares, and the balance in cash. The vendors pay all preliminary expenses up to the first allotment of shares.

THE MUNICIPAL ELECTRIC LIGHT AND POWER CORPORATION (LIMITED).—Registered by W. Webb and Co., 6, Essex-street, Strand, W.C., with a capital of £25,000 in 2,490 shares of £10 each, and 100 founders' shares of £1 each. Object, to generate, produce, supply and use in any manner electric or magnetic currents for the purposes of providing light, heat, motive power, &c. There shall not be less than three nor more than seven directors. Qualification, 25 shares of £10 each.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 7, 1889, amounted to £4,689.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this Company for the week ended June 7, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,230.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

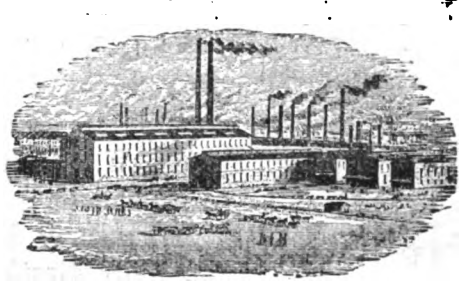
This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.



FACTORY.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, June 12, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 12, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	25/0	Do. Preferred	89 90	4 8 11	" "	90	89½
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	...	...
130,000	£10	5/0	Brazilian Submarine	13⅜ 14	5 0 0	Mar., June, Oct., Dec.	13⅛	13⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	103	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19 20	5 0 0	" "	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4⅛	4 4 8	March & September	...	...
6,000	5	5/0	Do. Preference 10%	8⅜ 9⅛	5 5 3	April and October	...	...
60,710	20	3/6	Direct United States	10½ 11	5 0 0	Jan., Apr., July, Oct.	10⅛	10⅜
380,000	10	2/6	Eastern	13⅛ 13⅜	4 9 9	" "	13⅜	13
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜ 15½	3 18 8	" "	15½	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109½	108
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	...	...
250,000	10	5/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13½
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	105½	105
179,177	10	3/0	Globe Telegraph and Trust	8 8½	5 0 0	Jan., Apr., July, Oct.	8 5/16	8
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 15	4 0 0	" "	15	14 5/16
150,000	10	5/0	Great Northern	15⅝ 16¼	4 12 4	Jan., July, and April	16	16
17,000	25	37/6	Indo-European	39 41	6 1 11	April and October	...⅛	...
9,000	8	8/0	Reuter's	7 7½	5 6 8	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	103	102½
80,000	10	2/0	West Coast of America	10 10½	5 14 3	January and July	10⅜	10¼
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2⅜	2 7/16
34,563	10	12/0*	Do. 1st Preference 6%	11¼ 12¼	...	April and October	12 5/16	11 13/16
4,669	10	...	Do. 6 per Cent. 2nd Preference	14 15	...	...	14⅜	14⅜
45,181	15	9/0	Western Brazilian	11⅜ 12¼	6 2 4	March & September	12⅜	12
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	4½d.	Consolidated Telephone and Maintenance	1⅜ 1⅝	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	5/16 7/16	3 15 8	...	⅜	...
80,000	5	12/6	United	15⅜ 16	5 9 5	June and December	16	15½
55,000	5	3/0	United River Plate	6⅜ 6⅝	...	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3⅜ 4¼	...	...	...	...
23,692	5	2/0	Do. (fully paid)	4⅜ 5	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	3¼ 3½	...	...	3 5/16	3⅜
			MISCELLANEOUS.					
87,350	12	36/0	Telegraph Construction and Maintenance	41 43	5 11 9	March and July	42½	42
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19⅝	19½

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 579.—Vol. XXIII. FRIDAY, JUNE 21, 1889. Price Fourpence.

NOTES.

The deputation which waited upon Sir Michael Hicks-Beach on Wednesday last had so good a case that, even had the duty fallen to less able spokesmen, it is scarcely conceivable that the Government could turn a deaf ear to their plea. The facts were clearly and succinctly stated in the letter of Lord Crawford and in the speeches of Lord Rayleigh, Sir William Thomson, Sir Vincent Barrington, and of Mr. Crompton. And the said facts simply amount to this—that in the absence of an official or officially recognised standardising laboratory the industry is powerless to fulfil the requirements of the Board of Trade, which it is bound by statutory enactment to obey. That it is the duty of Government to make a way through this *impasse* is a point which scarcely requires argument. That such a laboratory will also be of immense benefit to the industry at large is almost equally self-evident.

Honour to whom Honour is due! Now that the question of the Standardising Laboratory has entered upon its final stage and is tending towards an issue which it is impossible to doubt will be completely successful, it would be ungrateful not to recognise the fact that to Dr. Fleming more than to any other single individual is due the merit of publicly initiating the movement, and of quietly but persistently keeping it before the leaders of the scientific world. It was in November, 1885, that Dr. Fleming first directed attention to the question, by an able Paper read before the Society of Telegraph Engineers "On the Necessity for a National Standardising Laboratory for Electrical Instruments." As shewing the interest which the question awakened at that comparatively early date, it may be mentioned that no less than eighteen speakers took part in the discussion. Mr. Preece delivered an able and interesting speech, in which he strongly supported the movement, and amongst the visitors who spoke were Mr. Chaney, Chief of the Standard Department of the Board of Trade, and Mr. Whipple, of Kew Observatory. It is desirable, perhaps, to call attention to the fact, however obvious, that much if not all of the practical value of the laboratory will depend upon the man who is entrusted with the technical supervision of the establishment.

The second Conversazione of the Royal Society for the present session—being a Ladies' night—was, we need scarcely say, a brilliant success. The electrical exhibits were not as showy as is sometimes the case, but all were full of interest. The chief novelty was undoubtedly the improved form of the Grove Gas Battery, devised and exhibited by Mr. Ludwig Mond and Dr. Carl Langer; the device is decidedly ingenious, and may possibly prove of some economic value. In this cell the plates consist of a porous material, which has been impregnated with dilute sulphuric acid, and is built up on a leaden grid. Both surfaces are next coated with platinum foil, first pierced with innumerable fine holes and then covered with a thin film of platinum black. These coatings are insulated from one another, but are each in contact with a portion of the grid, which is made in two halves, placed back to back with the porous material filling the space between. A number of these elements are placed side by side, and air passages are so arranged that hydrogen can be passed between every alternate pair, and air along the others. The process of charging the battery, therefore, consists merely in passing those gases through until the finely divided platinum can absorb no more. The results are described by the inventors as follows:—

"One element, with a total effective surface of 774 square centimetres = 120 square inches, which is covered by 1 gramme of platinum black and 0·35 gramme of platinum leaf, shows an electromotive force of very nearly 1 volt when open, and produces a current of 2 amperes and 0·7 volt or 1·4 watt, when the outer resistance is properly adjusted. This current is equal to nearly 50 per cent. of the total energy obtainable from the hydrogen absorbed in the battery. The electromotive force decreases, however, slowly, in consequence of the transport of the sulphuric acid from one side of the diaphragm to the other. In order to counteract this disturbing influence the gases are from time to time interchanged. The battery works equally well with gases containing 30 per cent. to 40 per cent. of hydrogen, such as can be obtained by the action of steam, or steam and air, on coal or coke, if these gases have been sufficiently purified from carbonic oxide and hydrocarbons. The water produced in the battery by the combination of hydrogen and oxygen is carried off by the unconsumed nitrogen and an excess of air carried through it for this purpose."

Prof. S. P. Thompson repeated the experiment of magnetically rotating the plane of polarisation, and analysing by means of the eye of a cod, which he showed recently at the Physical Society. He also repeated the beautiful experiment of Röutgen, showing the expansion and contraction of the rings seen in quartz by convergent polarised light when the quartz plate is transversely electrified. Prof. Thompson's contribution further included some very fine illustrations of cobalt-plating by a new process of his own. Cobalt promises several advantages over nickel as a plating metal as soon as the demand is sufficient to reduce the price. Dr. J. A. Fleming exhibited some incandescent lamps arranged to show the so-called Edison-effect.

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It will be remembered that this consists in showing that if a lamp has a platinum plate carried on a wire sealed through the glass, placed between the loop when the lamp is in action, it is found that a galvanometer connected between the middle plate and the *positive* side of the carbon loop shows a current passing. If the galvanometer is placed between the middle plate and the *negative* side of the loop no current is found. The lamps exhibited shewed this effect very well. By shielding the negative leg with a glass or metal tube the effect is entirely stopped—so that is evidently due to convection either of carbon particles or of the residual gas. Dr. Fleming has carried out a series of experiments which have led to results of a curious character, and will no doubt form the subject of a future Paper.

By a somewhat singular coincidence, just at the time when the relations between the Telephone Companies and the Government are exciting attention in this country, the same question has become the subject of bitter controversy in Paris. In this case the facts may be briefly given as follows:—In 1879 the French Government granted a concession conferring the right of working Telephone Exchanges in France to La Société Générale des Telephones for a period of five years. In September, 1884, this concession was renewed for a further period of five years. In return for the privileges granted, the Company agreed to pay the State 10 per cent. of the gross receipts, and a like sum to the Municipality of Paris for the right of running their cables in the city sewers. The concession not only afforded no monopoly to the Company, but empowered the State to determine the agreement at any time by purchasing the whole undertaking for a sum to be fixed by experts. The Company has, up to now, expended fourteen millions of francs, and has paid an average dividend of 4¼ per cent. to the shareholders. It is now proposed that the Government should acquire and complete the existing telephone systems for a sum not exceeding ten millions of francs. Considerable dissatisfaction is naturally expressed that a suggestion of an openly confiscatory character should have been made; but perhaps the blame chiefly rests with those who originally entered into such an extraordinary arrangement. However harsh the action of the Government may appear, it would seem to be quite within the terms of the agreement.

The meeting of the American Institute of Electrical Engineers, which has just taken place in New York, would appear to have been one of the largest and most successful gatherings of that body which has yet been held. The presence and active support of such men as Prof. Rowland, Prof. Nichols of the Cornell University, and Prof. Elihu Thomson lent additional importance to the proceedings. Prof. Rowland delivered an address on "Modern Views in Respect to the Nature of Electric Currents," which will be read with the deepest interest on this side of the Atlantic. In this address the remarkable theoretical and experimental advances of the last year or two were presented with a freshness and grace of diction, combined with a studied simplicity, which it would be difficult too highly to admire. Prof. Nichols presented Papers, by students of the Cornell University, "On the Efficiency of the Arc Lamp," "On the Personal Error in Photometry," and "On the use of the Copper Coil Voltameter," all of which will well repay perusal. Prof. Elihu Thomson read a Paper on "Magnetism in its Relation to Induced Electro-Motive Force or Current," in which the ideas, if not invariably novel in themselves, are frequently expressed in a manner which will be quite fresh to the majority of our readers. We must also mention a very valuable Paper by Mr. W. H. Peirce, "On the Relation between the Initial and Average Efficiency of Incandescent Lamps," a subject of very great practical importance on which little or nothing has hitherto been made known.

The paper of Mr. Crocker, on Motor Regulation, presents a good summary of all the possible—and some of the impossible—ways of dealing with that interesting problem, so far at least as regards continuous-current motors. It will be seen that Mr. Crocker himself rather favours the idea of obtaining regulation by moving the armature bodily along the line of its shaft. In the absence of actual experience we confess that we should have supposed that this device would have a tendency to disturb the field of the machine, and thus to set up sparking. However this may be, it is a singular coincidence that on page 136 of the same issue in which we reprinted Mr. Crocker's Paper we had occasion to speak of the very early magneto machine of Woolrich, the Birmingham electro-plater. Now, on referring to his patent (No. 9,431 of 1842), it will be found that he described this very device of shifting the armature in order, in this case, to regulate the current. It would therefore appear highly probable that this is the earliest method of regulation applied to dynamo-electric machinery in general which is to be found on record.

Several trial trips have recently been made on the North Metropolitan Tramway Company's lines with an electric car and tender embodying the ideas of Mr. W. D. Sandwell, of the Victor Engineering Works, Holloway. In addition to his method of gearing, which possesses some novel features, the chief points of Mr. Sandwell's system are the employment of a single motor with two armatures and of a separate trolley for the accumulators, the motor being placed under the car itself. The motor, which has field magnets of the Siemens double magnetic circuit type and a Gramme armature, drives by a leather chain belt upon one or the other of two pulleys fitted to double shafting, the shaft of one pulley being hollow and fitting over that of the other. Upon this shafting are two small toothed wheels, gearing into two larger toothed wheels of different diameters on the car axle, so that by shifting the belt from one pulley to the other it is possible to obtain a considerable variation in speed. By this combination it is sought to gain the advantages of belt gearing for the high-speed transmission and of toothed gearing for the low speeds. The belt used on the experimental car has been severely tested, and has proved very satisfactory. The field magnets are mounted on a slide, and can be changed from one armature to the other by a few turns of a lever. This arrangement no doubt has its advantages if it can be shown that a motor armature, however well designed, is so much weaker than other parts of the apparatus that duplica-

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tion is a necessity. By employing a separate trolley for the storage cells Mr. SANDWELL lessens the amount of alteration required to adapt an ordinary tramcar to electric working, and completely obviates all danger of damage to the motor from leakage or spilling of acid, in addition to simplifying the operation of charging. The motor takes an average current of 40 amperes when running at 700 revolutions, and giving about 7·5 horse-power on the brake. The battery consists of 68 E.P.S. cells of the latest traction type, with a capacity of 140 ampere hours. The weight of the motor and gearing is something over half a ton, of the trolley and battery two tons, of the car three tons when light and nearly six tons when loaded. It is anticipated that an extensive trial of Mr. SANDWELL'S car will shortly be made.

THE Board of Trade has now completed and issued the "Model Order," which is to serve as a pattern for the Electric Lighting Companies of the Metropolis. At the time of writing it has not been long enough in our hands to admit of useful criticism.

THOSE of our readers who are concerned in Central Station Lighting projects will probably scarcely need to be reminded that by the Act of 1882 the time during which notice may be given to a local authority of intention to apply for a Provisional Order during the current year expires on July 1st.

WE learn that, in view of the pressure of work imposed upon the officials of the Telephone Companies owing to the amalgamation scheme now about to take effect, it has been decided to postpone the proposed Telephonic Convention until next year.

Ealing.—The renovated Maxim-Weston Company is taking steps to establish a central lighting station in the suburb of Ealing.

Foreign Import Duties.—The June number of *The Board of Trade Journal* contains a useful tabulated statement of the foreign import duties on dynamo-electric machinery and electric lamps.

Brazilian Order for Cable.—Rio advices, dated May 20, state that the Brazilian Government has ordered in London 5,500yds. of electric cable for the use of the torpedo factory belonging to the Navy department.

Electric Lighting Order Confirmation Bills.—The Bills for confirming the Board of Trade Provisional Orders for electric lighting at Birmingham, Liverpool and Swansea have now been issued as a Parliamentary Paper.

Telegraphic Cables in the Philippines.—The *Dia* states that the invitation for the construction of inter-insular cables in the Philippine Isles has been withdrawn, in the absence of any tender being sent in. It is stated that the conditions will be modified, and that tenders will be again invited.

Wire Samples.—We have received from the Telegraph Manufacturing Company of Helsby samples of fancy cotton covered wires, twin wires, and double silk covered flexible wires with various qualities of insulation. The whole are put into a very neat and convenient red cloth case, and are in appearance and size not unlike an ordinary guide-book.

Fireproof Insulation.—We have received from Mr. J. E. Hartley, of Birmingham, specimens of electric light wires covered with fireproof insulation; the coating appears to be treated with tungstate of soda or some similar compound. The use of such wires where there is the slightest danger of electric light wires communicating flame from one room to another in case of fire is highly to be recommended.

Chelsea.—The Chelsea Electricity Supply Company (Limited) have given the necessary statutory public notice that they have applied to the Board of Trade for a license for purposes set forth in their advertisement, and that all objections to the granting of such license must be lodged with the Board of Trade on or before the 8th August, 1889. This refers to the district assigned to this company by Major Marindin at the late Inquiry.

Official Telegraphic Messages in Brazil.—The cash receipts of the Brazilian Telegraphs for January are reported to have amounted to 68,056 milreis, while the official telegrams charged to the respective Government departments in the same month amounted to 61,191 milreis. Would it not be good policy, asks the *Rio News*, to cut down the official telegrams a little, and thus afford more facilities to private individuals who pay for the work done?

The Electric Sugar Swindle.—The New York correspondent of the *Daily News* says:—"William E. Howard, one of the leading spirits in the electric sugar-refining swindle, was found guilty yesterday of grand larceny of the first degree. The jury occupied only fifteen minutes in finding its verdict. Howard will be sentenced on Friday. The maximum punishmens is ten years' imprisonment. The other members of the company are to be tried as soon as possible.

The American Engineers at the Subway and at Deptford.—Under the guidance of Mr. J. H. Greathead, the engineer of the work, a large party of the American engineers visited the City and Southwark Subway on Wednesday morning. On the conclusion of their inspection they expressed high admiration of the work, and warmly complimented Mr. Greathead upon its execution. A second party of the American engineers visited the generating station of the London Electric Supply Corporation at Deptford.

Gillingham (Kent).—The local authorities at Gillingham, Kent, have received notification from the Gillingham Electric Light Supply Company of their intention to apply to the Board of Trade for a Provisional Order, to be confirmed in Parliament, giving them statutory powers to lay mains under the ground instead of overhead, and also for an authorisation to apply electricity for any private or public purposes within the district of Gillingham. The parochial authorities have decided not to oppose the application.

A "Long-Distance" Microphone.—Dr. Puluj has recently shown some interesting experiments at Prague with MM. Deckert and Homolka's microphone for long-distance telephony. The instrument consists of a round vibrating plate of carbon and of a thick carbon plate, into which notches are cut; between these two, little balls of platinised carbon are placed, which serve to conduct the current from one plate to the other. The results obtained are said to be better than those given by any microphone hitherto constructed.

The Lighting of the Strand District.—At the last meeting of the Strand Board of Works a letter was read from Messrs. Gatti, stating that they are able to supply electricity in the district to the extent of 8,000 lamps of 16 candle-power, and can extend it shortly to 30,000 lamps.—Mr. Laing said that he and Mr. Prescott, together with the Surveyor, attended before the Board of Trade and opposed the idea of any one company having a monopoly, which Mr. Courtenay Boyle endorsed. He would move that Messrs. Gatti have the same facilities as the Metropolitan.

Electric Motors at the Bank of England.—The Bank of England have decided to utilise their electrical plant for power purposes as well as lighting, and Messrs. Drake and Gorham have been instructed to erect one of their electric lifts for the conveyance of passengers and gold. Electric lifts are becoming somewhat general where electricity is available, and we understand that those which were erected at the London River Plate Bank, the English Bank of River Plate, the English Bank of

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Rio de Janeiro, &c., have never given the slightest trouble or cost anything for repairs.

The Western and Brazilian Telegraph Company and the Government Tax.—By the contract with the Government, this company is expressly exempted from all taxes in Brazil, whether general, provincial, or municipal, but the agreement offers no obstacle to the tax collectors. For some time, says a Rio paper, the managers and agents of the company have been called upon to pay a tax for "exercising a profession," and the company having appealed, the Treasury has decided against the company. As the paper quoted justly remarks, "those who make contracts with the Brazilian Government should make a note of this."

The Cost of Lighting H.M.S. "Exmouth."—A report upon the subject of the electric lighting of the training-ship "Exmouth" has recently been presented. The report stated that the Managers were anxious to secure the best form of lighting, not only as regards economy, but also as regards safety. Three years had elapsed since the electric lighting of the ship had been completed, and the Managers had come to the conclusion that the approximate annual cost of such system was £665, while the annual average cost of lighting the ship by means of colza oil during a similar period was £680. A positive saving had thus been effected, besides obtaining a greater security from fire, together with other advantages, including the greater cleanliness and extended opportunity of training the boys in all parts of the ship, irrespective of atmospheric conditions, so that the actual cost of the electric light could only be regarded as approximate.

The Telephone in the West.—By means of a new trunk line of the Western Counties and South Wales Telephone Company, telephonic communication is now established between Torquay and Plymouth and intermediate places. The following are the rates charged for calls made by either subscribers or the general public between Plymouth and the various towns mentioned:—To Plympton, 4d.; to Ivybridge, Totnes, and Paignton, 6d. each; to Torquay, Dartmouth, Brixham, and Newton Abbot, 9d. each. The next telephonic extension contemplated will be to Yelverton, where, in response to several requests, the company hope to be able to open a small exchange, to the advantage of the large number of Plymouth people resident in that town. The Plymouth Exchange is now provided with a multiple switchboard; ladies on duty can answer any call without moving. The late superintendent (Mr. Anderson) has just been succeeded by Mr. C. V. O'Donnell, a gentleman of considerable experience in telephonic matters. Mr. O'Donnell began under the United Telephone Company in London, and then joined the Western Counties as Superintendent of the West Hants and Dorset District. Subsequently he acted as manager of the Sheffield, Lincoln, Chesterfield and Nottingham line of the National Telephone Company, and then, rejoining the Western, was appointed to Plymouth.

Engineering Society, King's College, London.—On Thursday last Mr. Charles Mittelhausen read his presidential address to the above Society on "A Few Recent Engineering Advances." The author showed experimentally how sewage could be precipitated electrically by means of iron electrodes on a small scale, and indicated how this long known scientific fact had been turned to practical account with the Webster process. In referring to the execution of criminals by electricity, it was pointed out that exhaustive experiments had now demonstrated the superiority of alternating currents for that purpose. The series system of electrical traction was then taken up, and by means of a model it was shown how the system had been made a complete success by the use of highly insulated conductors. Speaking on the advantages of photography for engineers, Grunston's new patent shutter was mentioned both on account of the simplicity and accessibility of its mechanism. The author also referred to Messrs. Siemens Brothers' new Morse instrument and Edison's new phonograph, whilst, *à propos* the question of national defence, the newest methods of operating submarine mines was explained. In the civil engineering world the chief features of the Forth and Lansdowne bridges were described, whilst the address terminated in an apology for the much maligned Eiffel Tower. After a vote of thanks to Mr. Mittelhausen for his interesting Paper, the meeting adjourned.

Search Lights at Malta.—A night attack on Valetta took place on the 11th ult. The "Benbow," "Phaeton," "Landrail," and "Don," with two first-class torpedo boats, left Malta harbour, says the *United Service Gazette*, about 3.30 p.m., and steamed away to the south-eastward. At 8 p.m. the batteries were manned and the electric search lights swept the surface of the water in all directions, but it was considerably later before the attacking squadron hove in sight. In the meantime, two merchant steamers making for the harbour were so surprised by the search lights on them, and by two guns fired at one of them under the impression that she was the "Landrail," that they turned seawards again, and waited until the operations were concluded. When the attacking force came near the harbour the batteries opened fire, and the ships replied, steaming along in front of the forts at about 1,500 yards distance. The second-class torpedo-boats made a dash at the "Phaeton," but were at once seen, and fire was opened on them. As a spectacle the attack was very fine, but there was too bright a moon for the search lights to be efficiently tested in discovering ships or boats. As, however, the principal object of the operations was to decide if the search lights on shore were placed in the most effective positions, the moonlight was not of so much consequence. It is stated that the military authorities do not consider their lights are placed as well as they might be, and alterations are to be made accordingly.

The School of Electrical Engineering and Submarine Telegraphy, Prince's-street, W.—Examinations for the certificate of this school have recently been conducted by Mr. Gisbert Kapp, A.I.C.E., and Mr. Kempe, of the Engineer-in-Chief's office, General Post Office. For the certificate in Electric Lighting and Power Transmission, Mr. Kapp set a Paper in mechanical and another in electrical engineering, and he devoted many hours to a practical and *vivâ voce* examination of the students on (to quote his report to the managers) "Steam boilers, steam engines, secondary batteries, dynamos, arc-lamps, calibrating, resistance measurements, jointing, photometry, switches, and management of circuits, and practical use of graphic methods as applied to dynamos." A minimum average of 70 per cent. of full marks in the practical work, and of 60 per cent. in each of the two Papers, is a necessary condition of obtaining the certificate. Of eleven students at the practical examination, only three failed to exceed this minimum. Certificates in Electric Lighting and Power have accordingly been awarded, on Mr. Kapp's report, to the following gentlemen:—Messrs. Wm. J. Alexander, G. Horley, Th. Raaschon, F. Wallis. Mr. H. R. Kempe set two Papers, one upon Electrical Testing generally, and the second containing special and practical questions upon Telegraphy and Telephony, in which a minimum of 70 per cent. of full marks was required. As the result of his report, certificates in these subjects have been awarded to Messrs. Wm. St. J. Beale, H. C. Moberly, H. H. Paynter.

A "Fault" in an Ocean Cable.—The value of laying ocean cables containing two cores was shown, says the *Electrical World* (New York), during the violent storm of Nov. 25, 1888, when a fishing schooner, about 26 miles from Gloucester, Mass., dragged her anchor for some distance, until at last she hooked the Rockport cable of the Commercial Cable Company's system, riding to it for about 48 hours. It was found, when picking up the cable during the repair, that she had dragged along it for some 400 yards, tearing off the outer covering of jute and compound, also one of the armour wires, rolling it up into a tangled mass, and at last driving the end of the steel armour wire between the sheathing of the cable and through one of the cores, but leaving the other absolutely intact. With a single-core cable of the ordinary type communication would have been interrupted until repairs were effected; but in this case, by means of the uninjured core, traffic was passing continuously with the exception of a few hours, during which the repair steamer had the cable cut in order to remove the fault. Considering the extreme violence of the gale and the large size of the vessel, it is surprising that the cable did not part, and the incident speaks well for the mechanical strength of the cable. The repair was made by the steamship "Pouyer-Quertier," which was chartered for the purpose, as she was the only available cable steamer on this side of the Atlantic. Captain S. Fossard, who commanded the

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steamer, showed such great skill in manœuvring her, that although 2½ miles of cable was picked up and relaid across a tideway of four knots per hour, it was found, on completion of the repair, that the cable was only lengthened by a few yards. The electrical department on board was in charge of Mr. Charles Cuttriss, the company's electrician. This remarkable "fault" has now been placed on exhibition at the Paris Exposition by the Commercial Cable Company.

Leeds.—A meeting of the Electric Lighting Committee of the Leeds Corporation was held last week to consider the report of the Borough Engineer in reference to electric lighting in Leeds. The report was considered at great length, and it was agreed to adopt the recommendations it contained in reference to the lighting by electricity of the Council Chamber, the Courts of Justice, and the offices in the Town Hall and the Municipal Buildings. The proposal as to the establishment of a central electric station upon the "Midden" was deferred to a future meeting. It is proposed that the arc lamps shall be fixed in the streets surrounding the Town Hall. It is estimated that over 2,000 lamps will be required to illuminate the Town Hall and Municipal Buildings, and that the scheme will cost £3,000. At a subsequent meeting of the Electric Lighting Committee, held on Wednesday last, the Committee proceeded to discuss the terms of the report in detail. In the end it was resolved, on the motion of Alderman Tatham, seconded by Alderman Spark, "That the Council be recommended to carry out the electric light in and about the Town Hall and Municipal Buildings, as referred to in the report, at an estimated expenditure of £3,000." Further, it was decided to ask the Corporation to make application to the Board of Trade for a Provisional Order, authorising them to apply electricity to public and private lighting purposes within an area described in the report, at an estimated expenditure of £68,000. It was explained that the area alluded to comprises not only the central, but also the residential districts of the town A third recommendation is to the effect that when the Provisional Order has been obtained, the Council shall grant to the Committee the sum of £25,000, which represents the estimated outlay upon an initial installation of the electric light within a district set out in the report. It was mentioned that the £25,000 will form part of the suggested outlay of £68,000, and that for the former sum probably all within the prescribed area who wanted the light might be furnished with it, after which the plant might be added to as the demand for the new system of illumination increased.

Thunderstorms and Lightning.—At the meeting of the Royal Meteorological Society, held on Wednesday evening last, Mr. W. Marriott gave a graphic and interesting account of the recent thunderstorms which have prevailed over this country. On Sunday, June 2nd, a thunderstorm passed across the country in a northerly direction from Wiltshire about 3 a.m., and reaching Edinburgh by 10.44. It travelled at the rate of about 50 miles an hour. It is possible that this storm travelled still further north, and reached Kirkwall at 3.37 p.m. A severe thunderstorm prevailed over the neighbourhood of the Tweed between 11 a.m. and noon, and was accompanied by hail of very large size, some of the stones being 5in. in circumference. A very destructive storm occurred over the whole of the north-west of England and south of Scotland during the afternoon; much damage was caused by lightning, and very large hail fell over a large area. Some of the hailstones measured 7in. in circumference, and weighed 7oz. During the night of the same day a severe thunderstorm prevailed over Norfolk, which was also accompanied by very large hailstones, some of which were 5 to 6in. in circumference. On Thursday, the 6th, thunderstorms prevailed during the afternoon over the whole of the south-east of England. That which passed over the metropolis about nine o'clock was remarkable for the brilliant and continuous display of lightning. During the night and in the early morning of the following day a very destructive storm prevailed over the Eastern Counties, much damage being done by the lightning in the north-west of Norfolk. Several hailstorms occurred between two and three o'clock at Margate and Ipswich. During the afternoon of this day destructive thunderstorms prevailed over the whole of the Southern Counties, much damage being done by lightning, while at Tunbridge Wells there was a most remarkable hailstorm. One of the hailstones which was weighed was actually half a pound in weight. An interesting collection of over 40 photographs of lightning, taken during the storm on June 6th, was also exhibited to the meeting. In addition to the sinuous, ribbon, and meandering flashes of lightning, several photographs showed knotted, multiple, and dark flashes.

The Proposed Electrical and Engineering Exhibition in Edinburgh.—On the 13th inst., a deputation representing a large and influential committee of citizens waited upon the Lord Provost of Edinburgh, for the purpose of placing before his lordship a scheme which has been inaugurated for holding during the spring of next year an Electrical and Mechanical Engineering and Inventions Exhibition in Edinburgh, and to which we referred as being in process of incubation some weeks ago. There were present:—Bailie Walcot, Principal Grant Ogilvie Messrs. A. R. Bennett, National Telephone Company; David Allan Stevenson, C.E.; J. W. W. Barclay, Mitchell Thomson, Geo. E. Watson, C.A., interim secretary; J. Harrison, &c. Mr. Bennett explained to the Lord Provost that it was proposed to celebrate the opening of the Forth Bridge by holding such an Exhibition on a large scale, and one which would interest all classes of the community throughout Scotland. The Exhibition would probably be open for several months; and its attractions, from the fact that the greatest electrical engineers and inventors would be represented, would be undoubted. It was mentioned that the deputation represented a large committee, among whom were Profs. Tait, Armstrong, Crum Brown, and Chrystal, the Lord Justice-Clerk, and many others.—The Lord-Provost (whose patronage and that of the Council the deputation desired) said that he would give the matter his most favourable consideration, and, speaking in approving terms of the project, he said he would be glad to see the deputation before the Corporation on the following Tuesday at their meeting. At the meeting of the Edinburgh Town Council, held on Wednesday, the Council unanimously agreed to receive a deputation of citizens with reference to the proposed Exhibition. On the introduction of the deputation, Mr. A. R. Bennett drew attention to the backward state of Scotland with regard to electrical science, especially when compared with the United States of America, where electricity was applied to a multiplicity of objects, and entered into the everyday life of the citizens of even the smaller towns of the United States to such an extent that he had no hesitation in saying that the street Arabs in a Western town were more conversant with the present applications of electricity than many educated men among themselves. In order to illustrate the growth in the application of electricity, he said the Board of Trade returns showed that during the first three months of 1888 the exports of electrical apparatus from Great Britain amounted to £88,077, while for the corresponding period this year they were valued at £430,309, nearly five times as much, and bordering closely upon half a million pounds. He would ask what was Scotland's share of this amount? He was afraid it was very little indeed, for they could count on the fingers of one hand the number of manufacturing firms in Scotland. Notwithstanding the rate of progress of electricity — 185,000 miles a second — it had not travelled far into Scotland. The Exhibition would, he believed, show to the people in the North, who were badly supplied with the means of communication with other places, and owing to their distance from the coal fields had an indifferent supply of fuel, that they had in their great rivers — such as the Ness, Spey, and Tay — a wealth inferior only to the mines of Golconda. Prof. Armstrong expressed his entire sympathy with the project. They believed the project was good in itself—good commercially—and that it would be a benefit to this ancient city, and to the advancement of science. It would partake in a large degree of the character of an International Exhibition, inasmuch as many of the most astonishing practical developments of electricity came from the other side of the Atlantic or the Continent, and they would have concentrated in Edinburgh all that was best and most advanced in respect of the application of electricity and mechanical invention generally. The Lord Provost said they would carefully consider the subject. The subject was then remitted to the Lord Provost's committee.

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LIGHTNING CONDUCTORS.—VIII.

BY DR. OLIVER LODGE.

(Continued from page 246, Vol. XXII.)

Alternative Paths Experiments—*(Continued).*

There has been rather a long break in the appearance of these Papers, due mainly to other work, and I am rather tempted to interpolate here an account of "recoil-kick" experiments, because these are the experiments which prove the velocity of a pulse along a pair of isolated wires to be very closely indeed the velocity of light—a matter of some interest at the present time, because Hertz has, by his interference experiment, been led to a different conclusion, and asserts that waves go at a different speed along wires and through air. This being so, there is a difference between us, and the account of my experiments supporting the theory of Maxwell and Heaviside shall be proceeded with directly the record of alternative path experiment is concluded. I go on now from p. 246, Jan. 4.

Experiments in September, 1887.

46. The arrangement depicted in Fig. 9 was still employed; but a couple of pint jars were substituted for the two small Voss jars. The static capacity was by this change raised from 143 centimetres to 670 centimetres, or nearly fivefold. The A spark was 1·35 centimetres long between the knobs of the immersed discharges (or reduced to flat plates, 1·1 centimetres). It could be placed in either of the three positions shown in the figure, and its light was always screened off the B knobs. These were adjusted till the B spark between them was just failing, passing occasionally, but missing much more often. The alternative

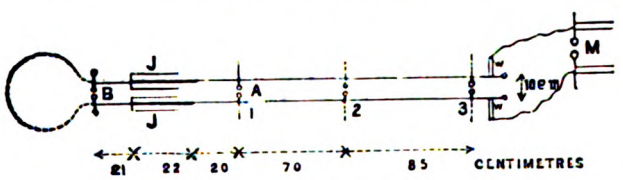

FIG. 9.

paths used were wire circles, about 2ft. in diameter, whose particulars are already recorded in Section 42. The following are the results:—

Pint Jars.

Alternative path.	Length of B spark for different positions of A, in millimetres.		
	Position 1.	Position 2.	Position 3.
None	6·50	7·35	8·50
No. 25 iron	5·8	4·7	3·65
No. 2 iron	5·0	—	2·0
No. 5 copper	5·0	—	2·0
No. 23 copper	5·85	—	2·5
No. 40 copper	6·3	—	4·5
No. 2½ brass	5·3	—	2·15
No. 24 brass	5·9	—	3·55

The pair of wires called "longer leads" were now inserted between the discharger and the jars, and the A spark had to be shortened to 7·5 millimetres. The following were now the readings of the B spark:—

Alternative path.	B spark in millimetres.	Alternative path.	B spark in millimetres.
None	10·55	No. 23 copper ...	·44
No. 5 copper	·22	No. 25 iron	·45
No. 2 iron	·25	No. 40 copper ...	·86

47. Applying theory to these experimental results, we deduce the following values for the rate of alternation per second, and for the maximum strength of current passing through the conductors.

The rate of alternation is slightly different for the different alternative paths. The extreme values are those for the thickest iron and the thinnest copper; so, taking them as examples, we have—

Pint Jars.

Thickest Wires.

Position of A knobs.	Rate of alternation.	Strength of max. current.	Impedance of alternative path.
No. 1	3·1 millions per sec.	3,000 amperes	7 ohms
No. 3	2·2 millions per sec.	2,500 amperes	5 ohms
End of longer leads	0·52 millions per sec.	[670 amperes]	1·2 ohms

Thinnest Wires.

No. 1	2·4 millions per sec.	2,700 amperes	10 ohms
No. 3	2·0 millions per sec.	2,500 amperes	8·5 ohms
End of longer leads	0·52 million per sec.	[660 amperes]	2·2 ohms

The strength of current put in square brackets in the third column is what corresponds to the same A spark length as in the other two columns. In actual fact this spark length had to be reduced because of leakage, and accordingly the current was reduced too in about the same proportion.

With the Voss jars the rate of alternation will be rather more than double and the current amplitude about half what is recorded for the two pint jars.

Comparison between Theory and Experiment.

48. Calculating absolutely to the length of B spark theoretically to be expected, by means of the first approximation, which ought to serve for this case, I do not find a good agreement when small jars are used, the Voss jars giving greater disagreement than the pint jars. The sparks observed are shorter than $\frac{L_0}{L+L_0}$ times the A spark. I am not prepared to say why this is, unless it be that loss by radiation damps out the vibration with these small capacities more quickly than one might suppose.

But it may be worth noticing that, taking merely relative numbers, the agreement is very fair. Thus, if we multiply the value $\frac{L_0}{L+L_0}$ by the factor 7·6 (instead of by 11, the length of the A spark between flat plates in millimetres), we get the column called "calculated (relative)" in the annexed table.

Pint Jars.

Alternative path, and position of A.	Calculated (Relative).	Observed.
No. 25 iron ... Position 1	5·9	5·8
No. 25 iron ... Position 2	4·6	4·7
No. 25 iron ... Position 3	3·6	3·7
No. 2 iron ... Position 1	5·1	5·0
No. 2 iron ... Position 3	2·7	2·0
No. 5 copper Position 1	5·2	5·0
No. 5 copper Position 3	2·8	2·0
No. 23 copper Position 1	5·8	5·0
No. 23 copper Position 3	3·5	2·5
No. 40 copper Position 1	6·2	6·3
No. 40 copper Position 3	3·9	4·5
No. 2½ brass ... Position 1	5·2	5·3
No. 2½ brass ... Position 3	2·8	2·2
No. 24 brass ... Position 1	5·9	5·9
No. 24 brass ... Position 3	3·5	3·6

The agreement here is not perfect, but it is not very bad.

49. When the longer leads are inserted, with a self-induction of about 1,000 metres, the same mode of calculation gives us the theoretical spark lengths for B as closely proportional to the self-induction of the alternate paths, but it is improbable that the first approximation is now sufficient, especially with the No. 40 wire. It is scarcely worth troubling about the second approximate in such a case as this, so I will proceed with the record of experiment, using the gallon jars instead of the pint.

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The A spark is still 1·35, and everything remains the same as before, the light being screened off.

The capacity charged is now 2,890 centimetres, except when the long leads are used, and then it is 3,040.

Gallon Jars.

Alternative path.	B spark length when half sparks fail, for different position of A.		
	A_1.	A_2.	A_3.
None	8·2	—	9·1
No. 5 copper	6·35	4·10	2·57
No. 2 iron	5·72	3·97	2·77
No. 25 iron	7·05	5·45	3·70
No. 23 copper	6·90	5·03	3·95
No. 40 copper	7·35	5·84	4·60
No. 24 brass	6·95	5·26	3·80
No. 2½ brass	6·25	4·10	2·45
No. 18 iron	6·40	4·60	3·14
No. 18 copper	6·80	4·95	3·12

50. Repeat with "longer leads" joined up to jar, with their far ends disconnected. A spark shortened to ·96, because otherwise it could not be got to form.

Alternative path.	B spark length for various positions of the A knobs.		
	Position 1.	Position 3.	Position 4. (Far end of long lead.)
None	6·8	7·0	19·25
No. 2 iron	4·65	2·10	·12
No. 5 copper	4·80	1·80	20
No. 40 copper	5·30	3·18	·48
No. 25 iron	4·95	2·85	·31
No. 23 copper	5·50	3·00	·25
No. 18 copper	5·28	2·70	·19
No. 18 iron	4·80	1·80	·16
No. 2½ brass	4·84	1·71	—
No. 24 brass	5·28	2·92	—

Comparison with Theory.

51. Taking the ratio $\frac{L_0}{L+L_0}$ and multiplying it by the length of the A spark, we get very fair accord between theory and experiment. But the agreement is still closer if instead of multiplying by 11 we multiply by an arbitrary factor 10 for the longer A spark and by 7·1 for the shortened one. The following table shows the comparison between calculation and observation for the longer A spark :—

Gallon Jars.

——		$\left\{\frac{10\,L_0}{L+L_0}\right\}$ Calculated (relative).	Observed B spark.
No. 25 iron	1	7·2	7·1
	2	5·7	5·5
	3	4·5	3·7
No. 2 iron	1	6·3	5·7
	2	4·5	4·0
	3	3·3	2·8
No. 5 copper	1	6·4	6·4
	2	4·7	4·1
	3	3·4	2·6
No. 23 copper	1	7·2	6·9
	2	5·5	5·0
	3	4·3	4·0
No. 40 copper	1	7·64	7·4
	2	6·1	5·8
	3	4·8	4·6
No. 2½ brass	1	6·4	6·3
	2	4·6	4·1
	3	3·5	2·5
No. 24 brass	1	7·2	7·0
	2	5·6	5·3
	3	4·3	3·8

52. Similarly, comparing theory and experiment with the shortened A spark, and with the long leads part of the charged conductors, we get the following table for each of the three positions tried :—

Gallon Jars and Long Leads.

——	Calculated (relative)	Observed.
No. 2 iron I.	4·4	4·6
No. 2 iron III.	2·3	2·1
No. 2 iron IV.	0·16	0·12
No. 5 copper I.	4·5	4·8
No. 5 copper III.	2·4	1·8
No. 5 copper IV.	0·17	0·20
No. 40 copper I.	5·4	5·3
No. 40 copper III.	3·4	3·2
No. 40 copper IV.	0·30	0·48
No. 25 iron I.	5·1	5·0
No. 25 iron III.	3·2	2·9
No. 25 iron IV.	0·25	0·31
No. 23 copper I.	5·1	5·5
No. 23 copper III.	3·0	3·0
No. 23 copper IV.	0·24	0·25
No. 18 copper I.	5·0	5·3
No. 18 copper III.	2·9	2·7
No. 18 copper IV.	0·21	0·19
No. 18 iron I.	5·0	4·8
No. 18 iron III.	2·9	1·8
No. 18 iron IV.	0·21	0·16
No. 2½ brass	4·5	4·8
No. 2½ brass	2·5	1·7
No. 2½ brass	0·16	—
No. 24 brass	5·1	5·3
No. 24 brass	3·0	2·9
No. 24 brass	0·25	—

Historical Note.

53. It has been everybody's opinion, I believe, that the original alternative-path experiment was performed by Faraday ; but Mr. Oliver Heaviside has been good enough to send me the enclosed extract showing that it is much older and is due to Priestley :—

Extract from John Cuthbertson's "Practical Electricity and Galvanism," dated 1807. Printed for J. Callow, London.

"An electric discharge prefers a short passage through the air to a long one through good conductors.

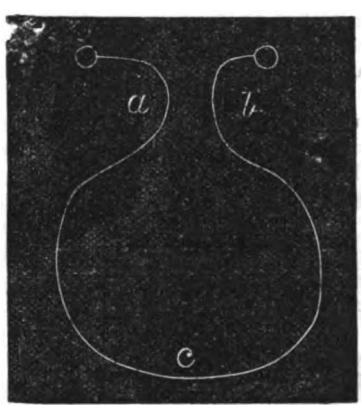

Fig 57

'Exp. 106.—Bend a wire, about 5ft. long, in the form represented by Fig. 57, that the parts *a b* may stand about a quarter of an inch from each other, then connect the end *a* to the outside of a battery or coated surface sufficient to melt wire. When it is charged set one leg of the insulated discharge upon *a* and make the other end to touch one of the knobs of the battery : it will be discharged. At the time of the explosion a spark will be seen between *a* and *b*, which shows that the electric fluid prefers a short passage through the air to a long one through the wire. This spark at first was supposed to contain the whole discharge, but the contrary is proved by the following experiment :

"Exp. 107.—Lay a small wire from *a* to *b* of such a thickness as the battery is capable of melting when charged to the same height as before ; discharge it, and the small wire will not be melted ; cut the large wire in two at *c* so as to disconnect the circuit, make a discharge as before, and the small wire will be melted by the same explosion which before scarcely made it red hot. In this manner Dr. Priestley, who is the inventor of this experiment, states the conducting power of different metals may be tried, using metallic circuits of the same length and thickness, and noting passage through the air in each case.

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THE PARIS EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT).

June 14, 1889.

From an electrical point of view the English section is very disappointing, the only firm exhibiting on anything like an extensive scale being Messrs. Crompton and Co., Chelmsford. The appearance of their stand, which measures 22ft. by 20ft., is somewhat spoilt from want of space; this is due to the fact that it was originally intended to drive the dynamo machines by coupling them direct to Willans' engines, but the recent fire at Thames Ditton prevented Messrs. Willans and Robinson completing the work in time, and at the last moment Westinghouse engines, from Scotland, had to be substituted.

There are three Westinghouse engines, each capable of developing 100 horse-power at a speed of 300 revolutions per minute; they are supplied with steam from the boilers at the station of the Exhibition Electric Lighting Syndicate, which is outside the Palais des Machines, and necessitates the steam being brought through 600ft. of 6in. piping, laid underground, and covered with the "United" asbestos composition. The pipes have a fall of one in twenty, ending in a separator and trap of Macdonal manufacture.

The Westinghouse engines are coupled to six dynamo machines by means of ordinary belting, working between 10ft. and 7ft. 6in. centres. One engine drives two low-tension machines, whilst each of the other engines drives one low and one high-tension machine.

Four dynamos only are required for the actual work being done, so that two machines and one engine are kept in reserve in case of breakdown.

The high-tension machines run twenty-four 25-ampere arc lamps of 5,000 candle-power each in series; these light the whole of the British and United States section as well as part of the French. The lamps are of a special pattern designed expressly for the Exhibition. The raising and lowering gear is similar to that employed at the Mansion House lighting some few years ago, consisting of a double pulley-block and fall arrangement counterpoised, working with Messrs. Walter T. Glover and Co.'s flexible conductors with 98/26 B.W.G. copper core. In consequence of this arrangement, Messrs. Crompton's lamps present by far the best appearance of any in this hall, as they are always hung at precisely the same height, and are not made unsightly by slack wires. It is not improbable that some other exhibitors will adopt the same method of suspension.

Owing to the great height from the ground, namely, 15 metres, at which these lamps are hung, Mr. Chamin, the engineer, has experienced very great difficulty in getting them down for trimming, as the existence of a travelling crane necessitates the lowering cord being 12 metres from the ground. From the end of the cord below the lamp is hung a ring 18in. diameter. Through this Mr. Chamin (who must be an expert toxophilist) shoots an arrow to which is attached a string, thus dispensing with a high step ladder that used to take three men to move it.

In addition to lighting the main hall, Messrs. Crompton have seventy-nine small arc lamps of 500 candle-power each in the upper gallery.

These are arranged in seventeen parallels of series of three, and in each series there is also placed a resistance. In the last series, where there is but one lamp, a correspondingly greater resistance is of course placed. The dynamo machine running this group of lamps gives an E.M.F. of 220 volts.

At the foot of the staircase, near the Avenue de la Bourdonnais, there are four iron standards to hold forty 16 candle-power lamps each. From the low-tension circuit there is being run a motor which drives one of Messrs. Avery and Co.'s cartridge-filling machines; it is believed that this is but one of many motors that will ultimately be seen running in the British and United States sections.

Blackpool Tramway.—We learn that on Whit-Monday over 11,000 passengers were carried by the Blackpool Electric Tramway, and the receipts amounted to more than £87.

REVIEWS.

Papers on Alternating Currents of Electricity. By T. H. BLAKESLEY, M.A. Second Edition. Specialists' series. (Whittaker and Co., London.)

We are glad to welcome a new edition of Mr. Blakesley's little book on "Alternating Currents of Electricity." Our readers will recollect that these Papers originally appeared in the columns of *The Electrician*, and afterwards were published in a separate form. The present edition will be found to embody some modifications and additions. At a time when two large and powerful corporations are making their preparations to provide electric illumination for a considerable area of the metropolis by means of alternating currents, it is certainly necessary that electrical engineers should have all the help they can obtain to assist them to master the vagaries of all sorts and conditions of periodic currents, and to grapple with the problems presented in their ordinary and extraordinary behaviour. The chief aim of the author of this book has been to exemplify the use of geometrical methods of dealing with these problems, on the assumption that the periodic character can be represented by a simple sine curve. It has sometimes been said that investigations of this kind have a purely theoretical interest, because practical periodic currents are not, or may not be generally, truly harmonic, and hence the electrical student is not much more helped by them than the student of mechanics is by mechanical text-books which treat of perfectly rigid levers, perfectly flexible cords and frictionless pulleys. The reply, however, is that in elementary teaching some completeness of treatment must at first be sacrificed for the sake of clearness; and next, that since all periodic currents of any kind are the result of superposition of simple periodic currents, an approximation to a first degree is still even in practice very useful; and lastly, that the not quite perfect theory may yet be a very useful guide in actual practice and be subsequently modified by experience to closer agreement with facts. Mr. Blakesley's book is divided into thirteen chapters. The first, which is headed Self-Induction, deals chiefly with the addition of simple periodic electro-motive forces when represented graphically by straight lines, the length of which is proportional to their maximum value, and whose simultaneous projection on any line gives their values at any instant. Mr. Blakesley's formulæ would be much simplified by letting the symbol T stand for the *complete* periodic time, by selecting some single symbol to denote $\frac{2\pi}{T}$, and finally by adopting the now frequently used term impedance for the oft-recurring expression $\sqrt{r^2+\frac{4\pi^2}{T^2}L^2}$. Long and unsymmetical formulæ like those on page 20 for the values of the primary and secondary current strengths in the case of two mutually inducing coils are thereby rendered much more expressive. In the second chapter on Mutual Induction Mr. Blakesley apparently objects to Mr. Willoughby Smith's use of the idea of magnetic screening in his experiments on metallic plates inserted between two inducing coils, and seems to imply that the effect of inserting such a screen is always to reduce the mean strength of the primary current. He quotes an experiment of his own with an induction coil having a telephone in its secondary circuit and a tuning-fork interrupter in its primary, and states that the insertion of the core (presumably iron) reduced the intensity of tone given by the tuning-fork, the inference being that the primary current was reduced in strength. This is quite in accordance with theory. The impedance of the primary circuit is increased by the insertion of the iron core; but Mr. Blakesley would have found a different result if he had used instead a solid copper core. Magnetic screening is an undoubted fact, and although objection may be taken to the interpretation put by Mr. Willoughby Smith on some of his results, the final reasons for belief in it rest on far broader foundations.

In Chapter III. we are brought to the subject of condensers charged by periodic currents, and the simple theory of the relation of charging current and potential difference is given. In Chapters IV. and V. the theory of condensers shunted by non-inductive shunts is established, and as a consequence we are

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introduced to the flow of periodic current in circuits having capacity. It would have been well first to have pointed out broadly to the student that a perfectly insulating condenser acts towards a periodic electro-motive force impressed on its terminals as if it were a non-dissipative conductor having a negative self-induction. In other words, it passes a certain quantity of electricity per second, but in the absence of true conduction or leakage there is no dissipation of energy involved. A circuit having self-induction resists the formation of a current in it, and when it is formed tends to propagate it in the same direction on the withdrawal of the force. A condenser acts in an opposite manner, and discharges its energy as a current in a direction against the impressed electro-motive force when this latter is removed. Accordingly the action of the condenser placed as a shunt across a portion of an inductionless series of incandescence lamp, is obviously (*see* p. 41) that of a conductor. It robs the further section of current and makes those lamps duller, while the lamps in the section near to the generator carry additional current for the condenser and are rendered brighter. Chapter VI. introduces us to the same subject considered when self-induction in the shunts and leads is involved. The practical case of a condenser and self-inductive circuit joined in series is treated, and it is shown that for a particular relation of periodicity, capacity, and inductance the coil and condenser in series permit a current to pass just as if the combination were a simple resistance without self-induction; in other words, the condenser placed in series with the coil annuls its self-induction. In Chapter VII. condenser transformers are explained. When a condenser is joined up to the ends of a non-inductive resistance the current in the resistance is always *less* than it would be if the condenser is removed, but if the resistance has self-induction then the current may be *greater*. This is equivalent to saying that the condenser annuls in part the self-induction of the coil. In high-speed telegraphy it has been found possible to greatly quicken the response of a relay by short-circuiting it with a condenser, the explanation being that the self-induction of the electro-magnet is partly annulled by the condenser.

The two following chapters deal with the flow of periodic currents in a circuit having capacity, say a submarine cable, and as a natural result involve a discussion of the problem of long-distance telephony. Mr. Blakesley puts very clearly what are the causes and conditions limiting long-distance telephony. The various simple tones which go to build up every complex sound are variously degraded in strength, and hence it arrives at the other end no longer having the same wave form. If every proportion of a face or figure is reduced in the same ratio we obtain a recognisable miniature or portrait, but if the sizes of component lines are variously reduced we get a *caricature*. The effect of electric capacity in a telephonic cable on a composite wave of current is similarly to change or burlesque the wave form, and hence render it impossible for the ear at the receiver to guess the original form when it has been disguised by this change beyond a certain amount. Chapter X. presents us with the problem of transmission of power by alternating currents. We think this chapter would have been more generally useful if it had dealt briefly with the practical experiments which have been made on that point. The general problem of the transmission of power by alternating currents is bound up with that of driving alternators in parallel circuit. It is now well known that separately driven alternators will in general "cophasedly synchronise" one another when put in parallel on the same circuit. All real alternators will not, however, do this equally well. Mr. Blakesley brings to bear his geometrical method to show—as had been done previously by Dr. Hopkinson, using analytical methods—that if under these circumstances one machine lags in phase behind its fellow, its work will be decreased, and it will be brought into phase again. The important question which, however, requires elucidation is the examination of the circumstances which contribute to produce the maximum stability. For practical success it is necessary that the smallest lag of one machine behind the other should be checked immediately; in other words, the least attempt to get out of step should bring into existence very considerable forces of restitution, and the equilibrium of cophasial synchronisation should be not only stable but hard to displace.

In the light of recent discussions on the question of the bearing of high or low armature self-induction or great or small periodicity on this mutual control of machines there can be no doubt that Mr. Blakesley will in another edition find further points to discuss before the problems can be considered exhausted. Chapter XI. contains a very useful and very practical discussion of the employment of the two-coil dynamometer to measure the phase difference of periodic currents and to measure self and mutual induction coefficients when simple periodic currents of known periodicity are available. These methods have been largely borrowed by Prof. Ferraris in investigations on transformers.

The final chapter discusses magnetic lag. There are two notions which are sometimes mixed up in using this phrase, which ought really to be kept separate. When an extremely small particle of soft iron is subjected to the sudden application of magnetising force, it may be that a small interval of time elapses before it reaches the state of magnetisation appropriate to this force. This delay, if it can be detected, is properly called magnetic lag. On the other hand, when an iron bar of finite size is subjected to external magnetising force, owing to the gradual evanescence of the surface eddy currents, which exert a reverse magnetising force, there is a delay in time occupied in propagating through the mass the magnetising force. As far as observation goes the result is the same, whether the delay in the appearance of full magnetisation is due to growth of magnetisation or growth of magnetising force. Mr. Blakesley's ingenious method with the three dynamometers really measures the lag of magnetic induction or magnetisation behind magnetising force, no matter what may be the ultimate nature of the cause. No subdivision of the iron gets rid entirely of eddy currents. Mr. Blakesley gives the result of one practical experiment, in which he found that the magnetisation in a small transformer core lagged 5deg. or 6deg. behind the magnetising force. Prof. Ferraris found that with solid iron cores the lag might be as much as 45deg. Mr. Blakesley's conclusion that whatever causes magnetic lag is also a cause of dissipation of energy in the core is undoubtedly a correct conclusion. On the whole, we can recommend this short treatise as a useful addition to the library of an electrician. It is written with great clearness and compactness of statement, and well maintains the character of the series of books with which it is now issued.

Days with Industrials. By A. H. Japp, LL.D., F.R.S. (London: Trübner and Co.)

This is a collection of essays relating to some of those curious industries about which little has been written except in encyclopædic form, including the cultivation of quinine, the boring for petroleum, the manufacture of artificial diamonds, and the like. There is a short article entitled "The Electric Telegraph," more than half of which is taken up with the pneumatic system of transmission, probably for the sufficient reason that the author knows nothing of telegraphy, as is evidenced by his describing the Wheatstone transmitter as being "turned by a handle."

Electric Light for the Million. By Arthur Frederick Guy. (London: Simpkin, Marshall and Co)

This little pamphlet announces itself as a handbook for the uninitiated, of practical information on electric lighting and its cost. In the short space of 31 pages the author deals with the progress and advantages of the electric light, its production, the various systems employed, the approximate cost of installing plant where a central-station service does not happen to be available, and concludes with practical hints and general remarks.

Although the subject is necessarily and indeed intentionally treated in the most superficial manner, yet the pamphlet should serve a useful purpose in showing those who are still prejudiced against the adoption of electricity how practicable it has become, and that it is no longer the expensive and erratic agency it was but comparatively few years back. We may add that the author understands his subject—a fact which painful experience teaches us is by no means to be taken for granted in books on electricity addressed to the million—and, moreover, his estimates may safely be taken as a fairly trustworthy guide to the probable expenditure.

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ELECTRICAL STANDARDISING LABORATORY.

DEPUTATION TO THE PRESIDENT OF THE BOARD OF TRADE.

On Wednesday a joint deputation from the London Chamber of Commerce and the Institution of Electrical Engineers had an interview with Sir Michael Hicks-Beach at the offices of the Board of Trade, to urge the Government to establish an Electrical Standardising Laboratory. The President was accompanied by Lord Balfour of Burleigh, Mr. Calcraft, Mr. Courtenay Boyle, Sir Thomas Blomfield, Major Marindin, and Major Carden, officials of the Board. The deputation consisted of Sir William Thomson (President of the Institution of Electrical Engineers), Lord Rayleigh, Sir Douglas Galton, Sir Vincent Barrington, Professors Geo. Forbes, Silvanus Thompson, Perry, Hughes, Adams, Powey, and Foster, Major Flood Page, General Webber, and Messrs. Crompton, Fleming, Lant Carpenter, Trotter, Kapp, Swinburne, Latimer Clark, Gaycke, F. B. Led, and Mr. Webb, secretary of the Institution of Electrical Engineers.

LORD RAYLEIGH introduced the deputation. He said they represented two bodies, the Electrical Section of the London Chamber of Commerce and the Institution of Electrical Engineers. The London Chamber had deputed three gentlemen to represent them—Lord Crawford and Balcarres, Sir John Lubbock, and Sir Vincent Barrington. Sir John Lubbock was abroad, and Lord Crawford was detained at Deptford, entertaining a party of American electricians, but he had written the following letter :—

"I am very sorry that I am unable to be present at the deputation to the President of the Board of Trade, as I have to receive a large number of American engineers who are visiting Deptford.

"Had I been able to speak to-morrow I had intended to have drawn attention mainly to the requirements of undertakers as affected by the clauses of the Provisional Orders, and to show that obligations are put upon them to supply all descriptions of instruments for measuring quantity or pressure of an electric current. That for which there is the greatest demand is the meter. Every consumer has a right to clean a meter which must be a 'certified meter,' *i.e.*, that it must have been compared with a standard and stamped as correct. An *uncertificated* meter will be of no *legal* use to us, as its readings cannot be taken as evidence. So much for quantity.

"Pressure has to be measured also, and we may be called upon to supply voltmeters.

"There are presently existing good and reliable forms of this instrument, but owing to the want of reliable standards, instruments are often found to vary as much as 8 to 10 per cent. *inter se*. Clause 47 (1) contemplates another form of meter, *i.e.*, an energy meter (watt-meter), which would be otherwise obtained by combining the results of the foregoing instruments.

"Up to this time not one of these instruments can be supplied to customers so as to comply with the clauses of the Order, and if I were to send in to the Department a batch of 100 meters for certification, there is no existing means at its disposal to enable us to conform to regulation. We hold, therefore, that the Department should without delay inaugurate a laboratory where we may send in our instruments to be passed in a manner similar to the procedure in the Weights and Measures Act. I think there is but little doubt but that such an establishment would very shortly pay its way, and would not be a burden on Her Majesty's Treasury. I consider that the average number of lights at the present time would be found to be about 30 per consumer; we are now putting up plant for the supply of 250,000 lights, which, according to the above-mentioned rate, would require some 8,000 meters (Coulomb meters). We shall soon lay down another station for about 250,000 lights, and this will involve more meters. These figures may practically be doubled, as there is one other undertaker who will certainly require an equal number of meters to be certified. Large numbers will also be required for the provinces. A small fee for certificates would suffice to pay the expenses of such a laboratory, as in addition to large numbers of new instruments, every time that an old one is interfered with for cleaning, &c., it will have again to be certified. There are many other important matters, but they are in able hands, so that I may well leave it with them.—Very faithfully yours, CRAWFORD."

LORD RAYLEIGH continued: The point to which Lord Crawford had there directed attention was the main object of the deputation. The time had arrived in which there was a certainty of an electrical supply on a large scale. That supply could not be afforded in accordance with the terms of existing legislation without the use of certified instruments, and at the present time there was no means of getting such certifications. There were many more competent to speak on this question and the importance of such an institution. His own experience had been principally on the scientific side. Ten years ago those electrical standards were in a rather uncertain position. There were 2 or 3 per cent. difference as to what the standards actually were, but that was a thing now of the past, owing to the labours of a good many men. The principal standards of resistance and current were not now uncertain, so that there was no difficulty in the issuing of certificates stating what the actual value of the instrument was. During the last few years a great deal of ingenuity had been displayed upon the invention of meters of various kinds, and these were now considered to be satisfactory. They might admit of improvement in the future, but the time had come when the Board of Trade should issue certificates, so as to put electrical measuring instruments in the same position as weights for ordinary measures now stood. The whole matter lay in a very small compass. Electrical engineers were to issue certificated standards, and there was at present no means of obeying the law

Sir WM. THOMSON then read the points which had been agreed upon to be submitted to the Board of Trade as follows :—

1. That it is impossible that the supply of electrical energy under statutory powers can be efficiently carried out without the provision of some means of standardising the meters and other instruments used in connection with such supply.
2. That the Board of Trade has recognised the necessity for this by inserting in Licenses and Provisional Orders clauses requiring that these meters, &c., shall be of a pattern approved by the Board of Trade as certified as correct by a properly-appointed inspector.
3. That the ordinary trade in electrical machines and instruments is much hampered and rendered uncertain by the want of generally recognised standards of electrical quantities.
4. That the required standards should be maintained by the Board of Trade as the department of Government entrusted with the administration of the Electric Lighting Acts, and as the warden of the standards of quantities used in other trades.
5. That being strongly impressed with the absolute necessity for the establishment of a standardising laboratory, where measurements of the various electrical quantities could be effected with the requisite precision, and whence certificates would be issued which would be accepted generally, the electrical section of the London Chamber of Commerce approached the Council of the Institution of Electrical Engineers on the subject.
6. That in consequence a joint committee of the two bodies was appointed to consider the matter, and that this committee has arrived at the following conclusions :—
   (*a*) That the absolute value of the accepted units of the various electrical quantities has now been determined with such accuracy that the possible error cannot exceed $\frac{1}{4}\frac{1}{0}\frac{1}{0}$, or one-quarter per cent. The most recent determinations may therefore be taken, for practical purposes, as correct, and no future corrections vitiating previous certificates need be apprehended.
   (*b*) That instruments and methods are now available by means of which the constancy and accuracy of measurement of electrical units and multiples of these units in a properly-equipped laboratory and under proper supervision can be assured.
   (*c*) That the cost of establishment of such a laboratory, exclusive of building, on the smallest scale suitable for the present requirements of the trade will not exceed the sum of £4,000.
   (*d*) That the joint committee aforesaid has devoted much time and consideration to the question and the estimate at which they have arrived is as close as it was possible to make.
   (*e*) That they further are of opinion that by charging moderate fees for comparisons and certificates, the Board of Trade would be in a position to remit the Treasury interest on this outlay, and also to provide fund for maintenance and possible extension of the laboratory.
7. That we have now the honour to bring the above-mentioned facts to your notice, and pray that they may receive the serious consideration of the Board of Trade.

He might say, from a scientific point of view, that the possibility of electrical measurement in the manner put before the President had become demonstrated within the last few years very much, he must say, from the labours of Lord Rayleigh. Through his labours the correct determination of the standard of resistance had been made. At the Paris Congress in 1881, the measurements of Lord Rayleigh in this country and of experimentisers from all parts of Europe were collated, and the present standard was founded on the result of the Conference. The result was that the possible error could not exceed one-quarter per cent. This was quite within the limits of all practical satisfactory determination. There was no one of the elements in which the trade question could come into prominence which would be practically modified at all by an error of one-quarter per cent., so that for trade purposes the measurement was perfect. With reference to the measurement of quantities, Lord Rayleigh had given them an accurate and trustworthy means of measuring electrical quantities by the electrolysis of silver and copper, and thus the unit of the electric current was now more accurately known. There was another unit called the Board of Trade unit. That was founded on the two that he had referred to, and the foundation of those two being complete, the Board of Trade pressed upon them to adopt a standard. The Act of Parliament ordered them to do this, but it could not possibly be done unless that which they asked for was done, or something equivalent, that would allow the Board of Trade to test with requisite accuracy for practical purposes the instruments which were to be used in the working out of the Electric Light Act.

Sir VINCENT BARRINGTON spoke on behalf of the Electrical Section of the London Chamber of Commerce. He said the Council of the London Chamber were entirely with this movement from a business point of view. He assumed the possibility of these measurements being made accurately. They knew that in France and Germany they were made by the Government, and standards were regulated by the Government, and they felt they could not carry out their contracts without a standard, and it was for that reason that they supported this deputation.

Mr. CROMPTON said, as representing to some extent those companies, namely, the Electrical Supply Companies, that Lord Crawford would have done very much better than himself, he could only corroborate everything that had been said by Lord Rayleigh, Sir William Thomson and Sir Vincent Barrington on the subject. It was quite impossible for them to carry out the provisions of the Model Order which he had lately been studying without having meters certified; and further than that, as a member of the electrical trade or profession, he might say that they were put to disadvantage in competition with those on the other side of the water, who had the advantage of making the whole

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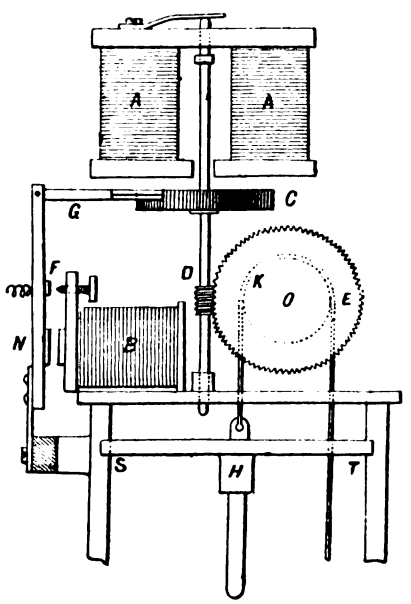
of their instruments and sending them for certification to Berlin and Paris, at which places Standardising Laboratories had recently been established. Those instruments when thus certified had a higher commercial value in the market of the world, and that fact alone ought to be some argument in favour of asking for this comparatively small sum of money to be expended, and expended if possible during this current year.

Sir MICHAEL HICKS-BEACH: Gentlemen, much that has been said has been, of course, necessarily of a highly technical character, and dealing with matters with which I cannot pretend to be specially conversant. But I think I understand the general purport of your deputation as embodied in the statement which was read by Sir William Thomson. I have only to say that I think in principle there are very good grounds for your request, and more than that I cannot say to-day, but I will look very carefully into it, and I shall, of course, have to bring the subject, if I feel able to do so, before that rather difficult department, the Treasury. I think you have put before me very good grounds for some such decision being made as you have requested.

LORD RAYLEIGH having thanked the right hon. gentleman for his courtesy the deputation withdrew.

THE POEGE ARC LAMP.*

The arc lamp devised by M. Poege, of Chemnitz, is shown diagrammatically in the annexed figure. The mechanism consists of an electro-magnet, A, the coils of which are placed in the main circuit; a circular armature, C; a fine-wire electro-magnet, B; an endless screw, D; a toothed wheel, E; a pulley, K; and a rack, G. When the current passes through the coils of A the armature C is attracted, and the screw D is consequently raised, turning the wheel E slightly and striking the arc. The electro-magnet B, its armature N, and the contact F form a vibrator arrangement, which comes into play whenever the shunt-current is sufficiently powerful—that is to say, whenever the arc becomes too long. These vibrations actuate the rack G, causing the armature C, which is provided with teeth, to rotate. The rotations of the armature cause the screw D to revolve, which in turn communicates its motion to the wheel E. The carbon-holder H, which is fixed to the guide-rod S T, is suspended by a cord wound round the wheel K, so that it now descends and re-establishes the proper length of arc. This lamp is very simple and well made. Its working leaves little to be desired.



Poege Arc Lamp.

BOOKS, &c., RECEIVED.

"Days with Industrials." By ALEXANDER H. JAPP, LL.D., F.R.S.E.

"*Proceedings* of the Canadian Institute, Toronto." Vol. XXIV., No. 151.

"Annual Report of the Canadian Institute," 1889.

"Board of Trade Journal" for June, 1889.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité" by kind permission of the author.

AMALGAMATION OF THE TELEPHONE COMPANIES.

The following letter has been addressed to the Secretary of the Post Office, in reply to his communication dated 4th inst., which appeared in *The Electrician* of the 7th :—

"The United Telephone Company (Limited), Oxford-court, Cannon-street, London, E.C., June 1[8], 1889.

"SIR: I am instructed by the directors of the United Telephone Company to acknowledge the receipt of your letter of the 4th instant. The directors are much surprised at the statement made by the Postmaster-General, that the amalgamation of the companies was not contemplated when the licenses were issued. It is impossible to suppose that the legal advisers of the Post Office were ignorant of the fact that it is competent for a company registered under the Joint-Stock Companies' Acts to liquidate and sell its business to another company similarly registered. Such an arrangement is one of almost daily occurrence, and if there had been any intention or desire on the part of the Postmaster-General, when these licenses were granted, to interfere with such an arrangement, the obvious course would have been to have inserted a clause in the license restricting the company's ordinary rights in this respect.

"The directors desire respectfully, but firmly, to join issue with the Postmaster-General on the question of fact. Even if the license had been silent on the subject it would have been impossible to suppose that the legal advisers of the Post Office had overlooked so obvious a point. But, as a matter of fact, the purchase by one company holding a license from the Postmaster-General of the Telephone Exchange business of another company holding a similar license was contemplated, and the license contains clauses (the precise wording of which was the subject of considerable discussion at the time) providing for the consequences which are to happen upon the sale by a company of the whole or of a part of its exchange business. One of these provisions (drawn by the Solicitor of the Department, and inserted after the license was in type) requires that seven days' notice of any such sale shall be given to the Postmaster-General. How, under these circumstances, it can be said that the possibility of such a sale was not contemplated when the licenses were issued, the directors are at a loss to understand.

"The Postmaster-General must surely have overlooked the fact that on three distinct occasions since the granting of these licenses companies or persons holding licenses to carry on the Telephone Exchange business have transferred their exchanges to other companies holding similar licenses without the slightest objection being raised by the Postmaster-General. In all these cases the sale was by a competing company to a company working under the United Telephone Company's patents. In the present case (as the Postmaster-General is aware) there is and can be no competition between the companies uniting, because although each company has a license from the Postmaster-General which entitles it to carry on the exchange business in any part of the United Kingdom, each company, by agreement with the others, works only in its own district. This fact was well known to the department at the time the licences were granted. The directors, therefore, fail to understand to what the Postmaster-General refers when he speaks of the state of things likely to result from the proposed amalgamation. The union will not affect the question of competition between the companies one way or the other, while it will undoubtedly lead to increased economy and efficiency in working.

"In objecting to the exercise by a Joint-Stock Company of its undoubted right to transfer its business to another company the Postmaster-General is seeking to impose upon the telephone companies the restrictions of a Parliamentary character without any of its privileges. As the Postmaster-General is aware, the United Telephone Company has more than once applied to Parliament for incorporation upon the lines recommended by the Parliamentary Committee which investigated the matter and reported in the year 1885, but the Postmaster-General has consistently opposed these applications.

"The directors venture to suggest that the interests of the public would be better served if the heavy tax imposed by the Department upon telephonic communication (a tax which is obviously really paid by the public in the shape of increased charges) were removed, and reasonable facilities were granted to the telephone companies, which would enable them to give to the public a cheaper and a better service. The directors have loyally carried out the engagements which they entered into with the Department when the terms of the present license were, after much consideration, settled by the late Mr. Fawcett, and they are unwilling to believe that the present Postmaster-General will attempt to reverse the policy of his predecessors, or to withdraw from any assurance, honourable or legal, given by the Department.—I am, Sir, yours obediently,

"THOS. BLAIKIE, Secretary.

"Sir S. Arthur Blackwood, K.C.B., General Post Office."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, June 22nd.

PHYSICAL SOCIETY.

3 p.m. "Researches on the Electrical Resistance of Bismuth." By Dr. EDWARD VON AUBEL.

MONDAY, June 24th.

LONDON CHAMBER OF COMMERCE.

4 p.m. Meeting

FRIDAY, June 28th.

SOCIETY OF ARTS.

8.30 p.m. Conversazione at the South Kensington Museum.

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The Electrician.

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Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months.
For Foreign Parts and Colonies:—	s. d.	s. d.	s. d.
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

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THE POSTMASTER-GENERAL AND THE TELEPHONE.

The hope we expressed only a fortnight ago that public attention would soon be directed to the question of the future of the Telephone has not had long to remain unsatisfied. Both the financial and political press have commented freely on Sir ARTHUR BLACKWOOD'S letter of the 4th inst., and the reply of the United Telephone Company's directors, which appeared in last Monday's *Times*, called forth in that journal the same day a leading article which is calculated to attract general attention to the importance of the question at issue. The matter now rests with the POSTMASTER-GENERAL, and as he can hardly afford to allow the United Telephone Company's letter to remain unanswered, we hope he will take the opportunity to express in more explicit terms his objections to the proposed amalgamation; and, what is of even greater importance, what he proposes to do supposing it is carried out in spite of his remonstrance.

As to the terms of his remonstrance—or warning, as it may be more fitly described—we are bound to say they were equally ambiguous on both the points referred to. If Mr. RAIKES' legal advisers were in the least doubt as to the legality of the proposed scheme, the companies themselves may well be excused the assumption that they are within their legal rights.

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The legal interpretation of the licenses is the very essence of the present dispute; and we strongly suspect that the public will share the view expressed by *The Times* that it would be very unfair to the companies to punish them for a defect in the wording of the licenses for which the departmental advisers were solely responsible. For this is really what the POSTMASTER-GENERAL, through Sir A. BLACKWOOD, seemed to contemplate in the second point to which he directs the companies' attention. Whether the amalgamation, he says, is legal or not, it was not contemplated when the licenses were issued; and any assurances given at that time cannot be regarded as applicable to the state of things likely to result from the proposed amalgamation. *The Times* interprets this as cancelling the original assurances that the rights of purchase reserved by the Post Office for the years 1890, 1897, or 1904, would not be exercised if a satisfactory public service were established, and as indicating that Mr. RAIKES intends to apply them on the earliest opportunity. Evidently some such understanding is referred to, and a threat of some kind is veiled under the statement that the changed circumstances, if carried into effect, will make the pledge no longer binding. But whatever it may have been, we think Mr. RAIKES has under-estimated the honourable obligation which is imposed on a public department by a promise of this kind, although not embodied in any legal document relating to the transaction. The public will take the view that the Post Office is bound by its promise, supposing it can be shown that the Post Office made it, and under conditions not now positively violated by the other parties.

Of course the question here arises, assuming the existence of "assurances outside the licenses," Are the companies abiding by their own outside, or implied, assurances, in attempting to amalgamate themselves into one solid corporation? Mr. BLAIKIE, speaking for the directors of the United Company, protests that they are breaking no understanding whatever, that the several companies have constituted a virtual monopoly all along, each in its own district, and that the projected amalgamation will make no practical difference in this respect, but will tend to benefit the public by reducing working expenses, and improving the telephonic service by consolidating it. These contentions are strictly true, and if the companies occupied the position of ordinary joint-stock traders, which is the attitude curiously taken up in Mr. BLAIKIE's letter, their position would be unassailable. But they forget they are arguing with one who knows perfectly well that this is not their position, and that they are trading only on a limited sufferance, and by the grace of Parliament, represented by the POSTMASTER-GENERAL for the time being. And the present POSTMASTER-GENERAL happens to conceive it to be his duty in the public interest to guard against some danger, the nature of which he does not specifically define, but which may easily be conjectured to be not precisely the one referred to by the companies themselves. No doubt the result of this correspondence will be to compel him to announce what it is that he apprehends and desires to avert. The public will then be able to judge between him and the companies; and it is quite time they were allowed to do so, for they are certainly entitled to be telephonically served either by the companies or by the Post Office; and this very interposition of the Post Office authorities shows that the time has arrived when the public ought to know which it is to be.

It will be seen that in the main we agree with the criticisms of our contemporary, *The Times*, so far as the published correspondence is concerned; but we strongly demur to its concluding deduction that a monopoly of the telephone service is undesirable either in the hands of the companies or of the Post Office. We do not pretend to say whether, had the Post Office retained its rights in the Telephone, the monopoly would have been worked to public advantage—though so far as the technical officers of the Post Office are concerned we need hardly say that we have every confidence in their ability to deal with the problem—but we are distinctly of opinion that by permitting a practical monopoly to the several telephone companies in their respective areas the public have been spared a most pernicious and ruinous competition, with an unendurable aggravation of the overhead wire nuisance. It should be noticed that Sir A. BLACKWOOD himself says nothing about monopoly; the word does not occur in his letter. What he is instructed to object to is amalgamation, which, he says, was not contemplated when the licenses were issued. The distinction has been practically maintained all along, the Post Office granting licenses which covered the whole country, but allowing private agreements between the parties that none would invade the territory of the others. Thus there has been what may be called competition by comparison in actual operation, and a potential competition of an active sort in reserve. The competition of the Post Office itself has never been seriously pushed save in one or two quarters; and the fact is at once creditable to the companies and proof that in the opinion of the Post Office "a real competition among telephone companies," such as is advocated by *The Times*, would have "delighted" nobody else. This being the policy and practice of the Post Office for the past nine years, we cannot suppose that any revolutionary change is contemplated now. All the more reason, however, for Mr. RAIKES to make known what is the change he actually does foreshadow in the enigmatical utterances with which he has recently startled and perplexed the telephonic world.

THE USES OF THE VOLTAIC BALANCE.

BY DR. G. GORE, F.R.S.

This instrument (sketch) is capable of being used for a variety of purposes. It has been employed for measuring the relative amounts of voltaic energy of aqueous solutions of many kinds of simple substances, compounds and mixtures (*see* Royal Society *Proceedings*, Vol. XLV., pp. 268, 442); to form volta tension series of a large variety of electrolytes, simple and compound (*ibid.*); for making similar measurements and tension series with different metals and alloys in such solutions; to discover chemical compounds in solution, and determine the combining proportions and valencies of their ingredients, the basicity of acids, &c. (*ibid.*, p. 265); to distinguish between chemical compounds and mere mixtures in aqueous solution; to assist in detecting substances in chemical analysis; to detect impurities in liquids; to measure the strength of aqueous solutions of substances; to investigate the limit of complexity of dissolved chemical compounds (*ibid.*, p. 266; also *Proceedings* Birmingham Philosophical Society, Vol. VI.); to measure losses of voltaic energy of substances during chemical union (*ibid.*); to discover dissolved isomeric compounds and detect differences of internal molecular structure of liquids (Royal Society *Proceedings*, Vol. XLV., p. 267); to discover unstable and spontaneously decomposable mixtures in solution (*ibid.*); to investigate the distribution of acids and bases in aqueous solution; to detect changes of chemical composition and measure losses and gains of voltaic energy of electrolytes, caused by heat, oxidation, deoxidation, or other influences, and measure the rates of chemical change (*ibid.*, p. 440); to detect and measure such changes in liquids, and their rates, during exposure to light or radiant heat, and investigate the influence of the nature, thickness, and colour of screens, etc.; probably also to measure the relative amounts of chemical energy of dissolved substances when uniting with metals; and for other purposes.

The method of measuring the amount of voltaic energy of a substance is as follows:—Take two small glass cups containing known volumes of distilled water. Form two voltaic

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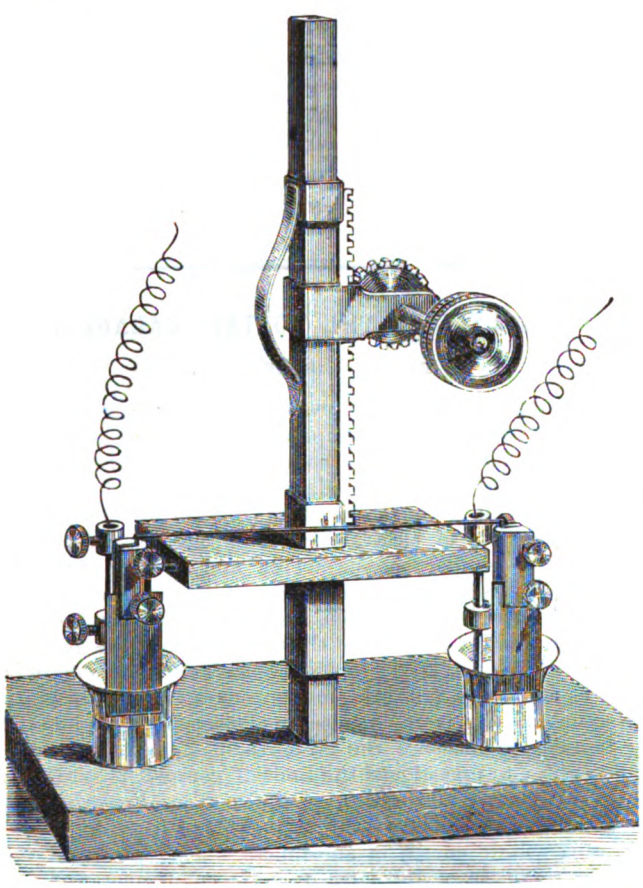
cells of them by means of strips or stout wires of unamalgamated zinc cut from the same piece, and two small sheets of platinum also cut from the same piece. Connect them in series to a sufficiently sensitive galvanometer, say one of from 100 to 1,000 ohms resistance, so that the currents from the two cells oppose each other and produce no visible deflection of the needles. This arrangement constitutes a "voltaic balance," and is extremely sensitive to change of chemical composition of the liquid in one of the vessels. Make an aqueous solution of known strength of the substance the energy of which is to be measured, and add it in sufficiently small quantities at a time to the water in one of the cups until the needles of the galvanometer visibly commence to move, and note the proportion of the substance and of water then contained in that vessel. As the amount of energy required to move the needles is the same in all cases, the different numbers thus obtained with different substances represent the relative amounts of voltaic energy of those substances under the same conditions, viz., kind of voltaic couple, galvanometer, and degree of temperature. The greater the proportion of water required to reduce the voltaic energy to the same amount, the greater is the voltaic energy of the substance (Royal Society *Proceedings*, Vol. XLV., pp. 268, 442). Care must be taken by occasionally heating the platinum to redness to avoid error caused by absorption of hydrogen.



Dr. Gore's Voltaic Balance.

By its aid, the voltaic influence upon magnesium of one part by weight of chlorine in 500,000 million parts of water has been detected; and the method is so sensitive, and the quantity of liquid required is so small, that "it would be easy to detect the effect of less than one ten-thousand-millionth of a grain of chlorine in one-tenth of a cubic centimetre of distilled water by this process" (*ibid.*, Vol. XLIV., p. 151). By removing the cups, substituting for them a horizontal strip of sheet platinum, placing a drop of distilled water upon one end, a drop of extremely dilute chlorine water upon the other end, and lowering two strips of sheet magnesium instead of zinc simultaneously into contact with the two liquids, and employing a very sensitive galvanometer, the total weight of chlorine necessary would be very much smaller than the amount mentioned.

To make the proper strength of chlorine water, take a freshly-made and pure solution, about three-fourths saturated, of known strength, and perfectly free from hydrochloric acid. Dilute it with distilled water in a tall and narrow graduated glass vessel to one part by weight in 1,000 parts of water. Add one part of this liquid to 999 parts of such water in a second similar vessel. Add one part of this second liquid to 999 parts of water in a third vessel; and use this third liquid to add to a suitable proportion of water in one of the cups of the balance. If the chlorine water contains any dissolved impurity its voltaic energy will be considerably diminished.

By the balance method has been measured the relative amounts of voltaic energy of more than 500 definite compounds and mixtures in aqueous solution—of elements with elements; elements with monobasic, bibasic, and tribasic acids; acids of all those classes with each other; elements with monobasic, bibasic, tribasic, and tetrabasic salts; monobasic, bibasic, and tribasic acids, with all these classes of salts; and all these salts with each other in similar great variety; and from the numbers thus obtained, volta tension series of these liquids with zinc and platinum have been formed, ranging in amount of energy from chlorine with a plus number of 1,282,000,000 to a certain mixture of salts which gives a minus number of – 959,817 (*ibid.*, Vol. XLV., p. 268).

In such series the halogens head the list, the acids come next then follow in succession acid salts, neutral salts, and then water, which forms the zero of the plus magnitudes; then come the alkaline salts, and finally the alkalies and their compounds, all giving minus numbers. With all members of the series above water, the electromotive force of the charged cell overcomes that of the water cell, whilst with all those below water the current from the latter cell overpowers that of the former and reverses the direction of deflection of the needles.

The method of discovering dissolved chemical compounds, and ascertaining their combining proportions by means of the "voltaic balance," is based upon the general truth that *when substances chemically combine they lose some of their voltaic energy or power of exciting a voltaic couple.*

The method is briefly as follows: "Dissolve in separate, equal, and known quantities of distilled water a series of several mixtures of the two constituents A and B of the supposed compound, in the proportion of their atomic or molecular weights and multiples of them, some having an excess of A and others of B. For instance, if both are monads, mix them in the several proportions represented by the formulæ 5 A + 4 B, 4 A + 4 B, and 4 A + 5 B; but if A is a monad and B a dyad, then use the proportions indicated by 3 A + 2 B, 4 A + 2 B, and 5A + 2 B."

"Add sufficiently minute quantities in succession of one of these solutions to the water of one of the voltaic couples until the needles of the galvanometer visibly commence to move and note the proportion added. Recharge the vessel with distilled water, clean the metals, and repeat the experiment with another of the solutions, and so on until all the solutions have been tried and the mixture has been found of which the largest proportion is required to move the needles; this is the one which has the smallest proportion of voltaic energy, has lost most energy by chemical union, and which has its constituents most strongly combined and chemically united in the usual definite proportions by weight, without an excess of either ingredient in a chemically free state." Mixtures may be known by their ingredients not being in the proportions of the ordinary chemical equivalents, and partly by their magnitudes of voltaic energy in relation to that of the true compound being usually larger. "The method may be used to ascertain the degrees of valency of substances, the basicity of acids, &c." (Royal Society *Proceedings*, Vol., XLV., p. 267).

By means of this instrument several hundreds of new chemical compounds, existing only whilst dissolved in water, and therefore termed "solution compounds," have been discovered, and a large amount of evidence has been obtained, supporting the conclusions "that there may probably be discovered thousands of such compounds, which exist only whilst in aqueous solution, and are decomposed on evaporating or crystallising their solution," and "*that every such electrolytic substance or mixture, when dissolved in water, unites chemically in de-*

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finite proportions by weight with every other such dissolved body," provided no separation of substance occurs (*ibid.*, p 267). A list of nearly 250 of these predicted substances, the existence of which has since been proved, has been communicated to the Royal Society (*ibid.*, p. 422), and many others have since been similarly found.

In the hundreds of instances yet examined, not a single one has been observed in which definite chemical union between two soluble substances has not been more or less clearly indicated by a minimum amount of voltaic energy, coinciding with the ordinary chemical equivalents of the substances; and this has occurred however complex the composition of the dissolved bodies.

As each substance in a pure state has, under the above-named conditions, a definite proportion of voltaic energy, and any soluble substance added in small amount to its solution diminishes that proportion, an impure substance can be readily detected by comparing it with the pure one in the voltaic balance. A given amount of energy alone, is not however, a characteristic test of a substance, except perhaps with chlorine, because several mixtures may give the same amount.

The method of determining the strength of liquids by means of this instrument is based upon the circumstance, that the greater the degree of concentration of a solution the larger is the amount of dilution required to reduce its voltaic energy to a given magnitude. For instance, the quantity of water required with one part of undiluted sulphuric acid, H^2SO^4, in one of the cups, in order to just visibly move the needles of the galvanometer, was 3,900,941 parts; if, therefore, the specimen of dilute acid required only half that proportion of water in order to produce that effect, it contained 50 per cent. of H^2SO^4. In using this method, it is necessary to know beforehand the amount of voltaic energy under the given conditions, either of the pure substance, or if it is impure, that of the particular undiluted sample.

In determining the degree of strength of solutions by this method, a much smaller amount of the dissolved substance is usually necessary than is required when it is determined either by that of specific gravity or by chemical analysis (see *Electrician*, Vol. 23, p. 71).

In order to examine the limit of complexity of composition of "solution compounds," two substances A and B are mixed together in the proportion of their chemical equivalents, and the amount of voltaic energy of the compound measured. A third substance in chemically equivalent amount to the first compound is now added, and the voltaic energy similarly measured. A fourth substance in equivalent proportion to the second compound is further added, and the energy also measured; and so on to any extent of complexity that may be convenient to examine. In all such cases, no substance should be added which causes a loss of dissolved matter, either by precipitation or by evolution of gas. As each successive addition of a new ingredient or increase of degree of complexity of the compound formed is attended by a loss of voltaic energy, this process is also a method of measuring the amounts of loss of such energy during chemical union.

By its means has been shown that there exists no apparent limit to the degree of complexity of "solution compounds," definite substances having been found possessing compositions represented by the formulæ, 4 K^2CrO^4; Na^2SO^4; K^2SO^4; 2 NaCl KCl; 8 K^2CO^3 (*Proceedings* Birmingham Philosophical Society, Vol. VI.); and K^2SO^4; 2 NaCl; 4 AmCl; 8 KCl; 16 KNO^3; 32 LiCl (Royal Society *Proceedings*, Vol. XLV., p. 266), thus rendering probable the inference that chemical affinity, feeble in degree, operates between large collections or aggregates of dissimilar molecules, provided the uniting aggregates are in the definite proportions by weight of the ordinary chemical equivalents.

Illustrations of the mode of detecting isomeric mixtures in solution have been communicated to the Royal Society (*ibid.*, p. 267).

Nearly every change of chemical composition of an electrolyte is attended by change of amount of voltaic energy. In order, therefore, to measure the rate of chemical change spontaneously going on in an aqueous solution—for instance, that of a mixture of equal proportions of potassic iodide and chlorine—we have to keep the solution in a stoppered glass bottle at an uniform temperature in the dark, and measure its voltaic energy at uniform intervals of time. By plotting as ordinates and abscissæ the losses of energy and the periods of time required, a curve of the rate of chemical change can be obtained. To ascertain the rate of change caused by heat, immerse a similarly-charged bottle in hot water, remove and cool it, and measure the energy, and so on repeatedly from time to time (Royal Society's *Proceedings*, Vol. XLV., pp. 440-441). By employing a liquid which is decomposed by light, such as chlorine water, the voltaic balance may be used to measure the intensity of light. The methods of using the instrument in measuring the rate of chemical change produced in liquids by light, radiant heat, oxidation, &c., are obvious from the information already given.

Other applications of the instrument to scientific research and to practical purposes remain to be made.

Messrs. Elliott, Brothers, St. Martin's-lane, London, have undertaken to make the instrument.

ON MODERN VIEWS WITH RESPECT TO THE NATURE OF ELECTRIC CURRENTS.*

BY PROF H. A. ROWLAND.

As, a short time since, I stood in a library of physical books, and glanced around me at the works of the great masters in that subject, my mind wandered back to the time when the apparatus for a complete course of lectures on the subject of electricity consisted of a piece of amber and a few light bodies to be attracted by it. From that time until now, when we stand in a magnificent laboratory with elaborate and costly apparatus in great part devoted to its study, how greatly has the world changed and how our science of electricity has expanded both in theory and practice, until, in the one case, it threatens to include within itself nearly the whole of physics, and in the other to make this the age of electricity.

Were I to trace the history of the views of physicists with respect to electric currents it would include the whole history of electricity. The date when the conception of an electric current was possible was that when Stephen Gray, about 170 years ago, first divided bodies into conductors and non-conductors, and showed that the first possessed the property of transmitting electric attractions to a distance. But it was only when the Leyden jar was discovered that the idea of a current became very definite. The notion that electricity was a subtle fluid which could flow along metal wires as water flows along a tube was then prevalent, and, indeed, remains in force to-day among all except the leaders in scientific thought. It is not my intention to depreciate this notion, which has served, and still serves, a very important purpose in science. But for many years it has been recognised that it includes only a very small portion of the truth, and that the mechanism by which energy is transmitted from one point of space to another by means of an electric current is a very complicated one.

Here, for instance, on the table before me are two rubber tubes filled with water, in one of which the water is in motion and the other at rest. It is impossible by any means now known to us to find out, without moving the tubes, which one has the current of water flowing in it and which has the water at rest. Again, I have here two wires, alike in all respects, except that one has a current of electricity flowing in it and the other has not. But in this case I have only to bring a magnetic needle near the two to find out in which one the current is flowing. On our ordinary senses the passage of the current has little effect; the air around it does not turn green or the wire change in appearance. But we have only to change our medium from air to one containing magnetic particles to perceive the commotion which the presence of a current may cause. Thus this other wire passes through the air near a large number of small suspended magnets, and, as I pass the current through it, every magnet is affected and tends to turn at right angles to the wire and even to move toward it and wrap itself around it. If we suppose the number of these magnets to become very great and their size small, or if we imagine a medium, every atom of which is a magnet, we see that no wire carrying a current of electricity can pass through it without creating the greatest commotion. Possibly this is a feeble picture of what takes place in a mass of iron near an electric current.

Again, coil the wire around a piece of glass, or, indeed, almost any transparent substance, and pass a strong current through the wire. With our naked eye alone we see no effect whatever, as the

* A lecture given at the College of the City of New York, May 22, 1889, before the American Institute of Electrical Engineers.

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glass is apparently unaltered by the presence of the current, but, examined in the proper way by means of polarised light, we see that the structure of the glass has been altered throughout in a manner which can only be explained by the rotation of something within the glass many millions of times every second.

Once more, bring a wire in which no current exists nearer and nearer to the one carrying the current, and we shall find that its motion in such a neighbourhood causes, or tends to cause, an electric current in it. Or, if we move a large solid mass of metal in the neighbourhood of such a current we find a peculiar resistance unfelt before, and if we force it into motion we shall perceive that it becomes warmer and warmer as if there was great friction in moving the metal through space.

Thus, by these tests, we find that the region around an electric current has very peculiar properties which it did not have before, and which, although stronger in the neighbourhood of the current, still extend to indefinite distances in all directions, becoming weaker as the distances increase.

How great, then, the difference between a current of water and a current of electricity. The action of the former is confined to the interior of the tube, while that of the latter extends to great distances on all sides, the whole of space being agitated by the formation of an electric current in any part. To show this agitation, I have here two large frames with coils of wire around them. They hang face to face about 6ft. apart. Through one I discharge this Leyden jar, and immediately you see a spark at a break in the wire of the other coil, and yet there is no apparent connection between the two. I can carry the coils 50ft. or more apart, and yet, by suitable means, I can observe the disturbances due to the current in the first coil.

The question is forced upon us as to how this action takes place. How is it possible to transmit so much power to such a distance across apparently unoccupied space? According to our modern theories of physics there must be some medium engaged in this transmission. We know that it is not the air, because the same effects take place in a vacuum, and, therefore, we must fall back on that medium which transmits light and which we have named the ether—that medium which is supposed to extend unaltered throughout the whole of space, whose existence is very certain, but whose properties we have yet but vaguely conceived.

I cannot, in the course of one short hour, give even an idea of the process by which the minds of physicists have been led to this conclusion, or the means by which we have finally completely identified the ether which transmits light with the medium which transmits electrical and magnetic disturbances. The great genius who first identified the two is Maxwell, whose electro-magnetic theory of light is the centre around which much scientific thought is to-day revolving, and which we regard as one of the greatest steps by which we advance nearer to the understanding of matter and its laws. It is this great discovery of Maxwell which allows me, at the present time, to attempt to explain to you the wonderful events which happen everywhere in space when one establishes an electric current in any other portion.

In the first place, we discover that the disturbance does not take place in all portions of space at once, but proceeds outwards from the centre of the disturbance with a velocity exactly equal to the velocity of light; so that, when I touch these wires together so as to complete the circuit of yonder battery, I start a wave of etherial disturbance which passes outward with a velocity of 185,000 miles per second, thus reaching the sun in about eight minutes, and continuing to pass outwards for ever, or until it reaches the bounds of the universe. And yet none of our senses inform us of what has taken place unless we sharpen them by the use of suitable instruments. Thus, in the case of these two coils of wire, suspended near each other, which we have already used, when the wave from the primary disturbance reaches the second coil we perceive the disturbance by means of the spark formed at the break in the coil. Should I move the coils further apart, the spark in the second coil would be somewhat delayed, but the distance of 185,000 miles would be necessary before this delay could amount to as much as one second. Hence the effects we observe on the earth take place so nearly instantaneously that the interval of time is very difficult to measure, amounting in the present case to only $\frac{1}{1500000}$th of a second.

It is impossible for me to prove the existence of this interval, but I can at least show you that waves have something to do with the action here observed. For instance, I have here two tuning-forks mounted on sounding-boxes and tuned to exact unison. I sound one and then stop its vibrations with my hand; instantly you hear that the other is in vibration, caused by the waves of sound in the air between the two. When, however, I destroy the unison by fixing this piece of wax on one of the forks the action ceases.

Now, this combination of a coil of wire and a Leyden jar form a vibrating system for electricity, and its time of vibration is about 10,000,000 times a second. This second system is the same as the first, and therefore its time of vibration is the same. You see how well the experiment works now because the two are in unison. But let me take away this second Leyden jar, thus destroying the unison, and you see that the sparks instantly cease. Replacing it, the sparks reappear. Adding another on one side, and they disappear again, only to reappear when the system is made symmetrical by placing two on each side.

This experiment and that of the tuning-forks have an exact analogy to one another. In each we have two vibrating systems connected by a medium capable of transmitting vibrations, and they both come under the head of what we know as sympathetic vibrations. In the one case, we have two mechanical tuning-forks connected by the air; in the other, two pieces of apparatus, which we might call electrical tuning-forks, connected by the luminiferous ether. The vibrations in one case can be seen by the eye or heard by the ear, but in the other case they can only be perceived when we destroy them by making them produce a spark. The fact that we are able to increase the effect by proper tuning demonstrates that vibrations are concerned in the phenomenon. This can, however, be separately demonstrated by examining the spark by means of a revolving mirror, when we find that it is made up of many successive sparks corresponding to the successive backward and forward movements of the current.

The fact of the oscillatory character of the Leyden jar discharge was first demonstrated by our own countryman, Henry, in 1832, but he pursued the subject only a short distance, and it remained for Sir William Thomson to give the mathematical theory and prove the laws according to which the phenomenon takes place.

Thus, in the case of a charged Leyden jar whose inner and outer coatings have been suddenly joined by a wire, the electricity flows back and forth along the wire until all the energy originally stored up in the jar has expended itself in heating the wire or the air where the spark takes place and in generating waves of disturbance in the ether which move outward into space with the velocity of light. These etherial waves we have demonstrated by letting them fall on this coil of wire and causing the electrical disturbance to manifest itself by electric sparks.

I have here another more powerful arrangement for producing electro-magnetic waves of very long wave length, each one being about 500 miles long. It consists of a coil within which is a bundle of iron wires. On passing a powerful alternating current through the coil the iron wires are rapidly magnetised and demagnetised, and send forth into space a system of electro-magnetic waves at the rate of 360 in a second.

Here, also, I have another piece of apparatus for sending out the same kind of electro-magnetic waves, and, on applying a match, we start it also into action.* But the last apparatus is tuned to so high a pitch that the waves are only $\frac{1}{50000}$ inch long, and 55,000,000,000,000 are given out in one second. These short waves are known by the name of light and radiant heat, though the name radiation is more exact. Placing any body near the lamp, so that the radiation can fall on it, we observe that when the body absorbs the rays it is heated by them; the well-known property of so-called radiant heat and light. Is it not possible for us to get some substance to absorb the long waves of disturbance, and so obtain a heating effect? I have here such a substance in the shape of a sheet of copper, which I fasten on the face of a thermopile, and I hold it where these waves are the strongest. As I have anticipated, great heat is generated by their absorption, and soon the plate of copper becomes very warm, as we see by this thermometer, by feeling it with the hand, or even by the steam from water thrown upon it. In this experiment the copper has not touched the coil, or the iron wire core, although if it did they are very much cooler than itself. The heat has been produced by the absorption of the waves in the same way as a blackened body absorbs the rays of shorter wave length from the lamp, and in both cases heat is the result.

But in this experiment, as in the first one, the wave-like nature of the disturbance has not been proved experimentally. We have caused electric sparks, and have heated the copper plate across an interval of space, but have not in either of these cases proved experimentally the progressive nature of the disturbance.

A ready means of experimenting on the waves, obtaining their wave length and showing their interferences, has hitherto been wanting. This deficiency has been recently overcome by Prof. Hertz, of Carlsruhe, who has made a study of the action of the coil, and has shown us how to use it for experiments on the etherial waves whose existence had before been made certain by the mathematics of Maxwell.

I scarcely know how to present this subject to a non-technical audience and make it clear how a coil of wire with a break in it can be used to measure the velocity and wave length of etherial waves. However, I can but try. If the waves moved very slowly, we could readily measure the time the first coil took to affect the second, and show that this time was longer as the distance was greater. But it is absolutely inappreciable by any of our instruments, and another method must be found. To obtain the wave length, Prof. Hertz used several methods, but that by the formation of stationary

* The lecturer here lit a gas flame.

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waves is the most easily grasped. Mr. Ames holds in his hand one end of a spiral spring, which makes a very heavy and flexible rope. As he sends a wave down it, you see that it is reflected at the further end, and returns again to his hand. If, however, he send a succession of waves down the rope, the reflected waves interfere with the direct ones, and divide the rope into a succession of nodes and loops, which you now observe. So a series of sound waves, striking on a wall, form a system of stationary waves in front of the wall. Indeed, we can use any waves for this purpose, even etherial waves. With this in view Prof. Hertz established his apparatus in front of a reflecting wall, and observed the nodes and loops by the sparks produced in a ring of wire, somewhat resembling the coil I have been using on the present occasion, but much smaller. It is impossible for me to repeat this experiment before you, as it is a very delicate one, and the sparks produced are almost microscopic. Indeed, I should have to erect an entirely different apparatus, as the waves from the one before me are nearly quarter-mile long, the time of vibration of the system being very great, that is $\frac{1}{100000000}$th of a second. To produce shorter waves, we must use apparatus tuned, as it were, to a higher pitch, in which the same principle is, however, employed, but the etherial waves are shorter, and thus several stationary waves can be contained in one room.

The testing coil is then moved to different portions of the room, and the nodes are indicated by the disappearance of the sparks, and the loops by the greater brightness of them. The presence of stationary waves is thus proved, and their half waves length found from the distance from node to node, for stationary waves can always be considered as produced by the interference of two progressive waves advancing in opposite directions.

However interesting a further description of Prof. Hertz's experiments may be, we have gone as far in that direction as our subject carries us, for we have demonstrated that the production of a current in a wire is accompanied by a disturbance in the surrounding space; and although I have not experimentally demonstrated the etherial waves, yet I have proved the existence of electric oscillations in the coil of wire and the ether surrounding it.

Our mathematics have demonstrated, and experiments like those of Prof. Hertz have confirmed the demonstration, that the wave disturbance in the ether is an actual fact.

The closing of a battery circuit, then, and the establishment of a current of electricity in a wire, is a very different process from the formation of a current of water in a pipe, though after the first shock the laws of the flow of the two are very much alike. But even then the medium around the current of electricity has very strange properties, showing that it is accompanied by a disturbance throughout space. The wire is but the core of the disturbance, which latter extends indefinitely in all directions.

One of the strangest things about it is that we can calculate with perfect exactness the velocity of the wave propagation and the amount of the disturbance at every point and at any instant of time; but as yet we cannot conceive of the details of the mechanism which is concerned in the propagation of an electric current. In this respect our subject resembles all other branches of physics in the partial knowledge we have of it. We know that light is the undulation of the luminiferous ether, and yet the constitution of the latter is unknown. We know that the atoms of matter can vibrate with purer tones than the most perfect piano, and yet we cannot even conceive of their constitution. We know that the sun attracts the planets with a force whose law is known, and yet we fail to picture to ourselves the process by which it takes our earth within its grasp at the distance of many millions of miles and prevents it from departing for ever from its life-giving rays. Science is full of this half-knowledge, and the proper attitude of the mind is one of resignation toward that which it is impossible for us to know at present, and of earnest striving to help in the advance of our science, which shall finally allow us to answer all these questions.

The electric current is an unsolved mystery, but we have made a very great advance in understanding it when we know that we must look outside of the wire at the disturbance in the medium before we can understand it—a view which Faraday dimly held fifty years ago, which was given in detail in the great work of Maxwell, published sixteen years since, and has been the guide to most of the work done in electricity for a very long time—a view which has wrought the greatest changes in the idea which we have conceived with respect to all electrical phenomena.

The Lighting of the "Victoria and Albert."—According to the *World*, the electric light machinery on the Royal yacht "Victoria and Albert," "which was so noisy that the Queen vowed that she would never again sleep on board until it was removed," has been transferred to the Admiralty yacht "Enchantress."

ELECTRIC MOTOR REGULATION.*

BY FRANCIS B. CROCKER.

(*Continued from page 148.*)

The second table gives a list of the possible cases of motor regulation which may occur with direct or continuous currents. There are four supremely important quantities or conditions in connection with electric motor regulation, viz., potential, current, speed and load, and it is with reference to one or more of these that practically all motors are designed, built, sold and used. Motors are always distinguished, both in science and in trade, as constant-potential or constant-current motors; constant or variable speed motors, and constant variable load motors; hence a classification of motors based upon the constancy or variability of these four factors is very convenient, and at the same time scientifically correct. The second table is made upon this plan, and in it the four quantities are represented by their initial letters P, C, S and L, expressed respectively in volts, amperes, revolutions per minute and torque in pounds at one foot radius, these being the units ordinarily used in practical as well as scientific work. We find that there are in all sixteen different cases, in the first four of which the potential is constant, in the second four the potential and current are both constant, in the third four the current only is constant, and in the fourth four neither the current nor the potential is constant.

TABLE II.—List of Possible Cases with Direct Currents.

P = Difference of potential in volts at terminals of motor.
C = Current in amperes supplied to motor.
S = Speed of armature in revolutions per minute.
L = Load or torque in lbs. at one foot radius.

Any of these four quantities may be either constant or variable, making the following combinations:—

Case.	Constant.	Variable.	Example.
1.	P	C S L	Series wound motor with variable load on constant potential circuit.
2.	P S	C L	Shunt or compound-wound motor with variable load on constant potentia circuit.
3.	P L	C S	Shunt motor with constant load and variable field resistance on constant-potential circuit.
4.	P S L	C	Not practical.
5.	P C	S L	Not likely to occur.
6.	P C S	L	Impossible.
7.	P C L	S	Impossible.
8.	P C S L		Shunt motor with constant load on constant-potential circuit.
9.	C	P S L	Shunt motor with variable load on constant-current circuit.
10.	C S	P L	Series motor with speed governor and variable load on constant-current circuit.
11.	C L	P S	Series on arc constant torque.
12.	C S L	P	Not practical.
13.	S	P C L	Motor with speed governor and variable load on circuit of variable potential and current.
14.	S L	P C	Motor with constant load and speed governor on circuit of variable potential and current.
15.	L	P C S	Motor with constant load without speed governor on circuit of variable potential and current.
16.		P C S L	Motor with variable load without speed governor on circuit of variable potential and current.

Case 1, in which the potential alone is constant, is the case of a series-wound motor, for example, with variable load on a constant potential circuit. Such a motor would rise in speed when the load was reduced, and *vice versâ*. It would not be at all self-regulating—in fact, it would tend to run at a very high speed with light load, and a very low speed with a heavy load. It is possible to give various other examples, but one is sufficient in most cases. In this case, however, I may say that the ordinary street-car motor, fed from a constant-potential circuit, is also an example of Case 1, the current being controlled by varying the external or internal resistance according to one of the methods given in the first table.

Case 2 is that of the ordinary shunt or differential motor, with a variable load on a constant-potential circuit. This is self-regulating and maintains its constant speed, as already stated, and is the com-

* A Paper read before the American Institute of Electrical Engineers New York, May 22, 1889.

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monest case of motor regulation met with. The current varies directly with the load.

Case 3 is that of the ordinary shunt motor with constant load, having a variable resistance in the field magnet. This case is shown in Fig. 1. Increasing resistance of field circuit would weaken the field magnetism, and the motor would run faster and take more current, *i.e.*, current would vary directly with speed.

Case 4 is not a practical one, because, if potential speed and load are constant, the current cannot be varied without wasting it—that is, any excess of current would be simply destroyed, which, of course, is not permissible.

Case 5 is not likely to occur, because potential and current would not be constant with a variable load and speed, but if it did occur it would require that the speed and load should vary inversely.

Cases 6 and 7 are not practical, for the same reason as given in Case 4, because if potential current and speed were constant the load could not be reduced without wasting electrical energy, and in Case 7 the speed could not be varied without wasting energy.

Case 8 is that in which all four factors are constant, and is best illustrated by a shunt motor with constant load on a constant-potential circuit, in which case the current and speed would also be constant.

Case 9 may be illustrated by a shunt motor with variable load on a constant-current circuit. The speed would run up as the load reduced. A more common example is a series motor on constant-current circuit, with switch for cutting out field coils, or, in short, a constant-current motor with variable speed and load.

Case 10 is that of the regular constant-current or "arc" motor with governor, such, for example, as the Baxter or "C. and C.;" it is a series motor with a centrifugal governor which operates a switch to cut in and out the field coils as shown in Fig. 3. This is, next to the shunt and differential-wound motors, the most common and important case of motor regulation.

Case 11 is that of a constant-current motor with constant load, with switch for varying field strength. The potential would rise directly with speed, but this case is not likely to occur.

Case 12 is not practical for the same reason as given in Case 4.

The last four cases are those in which both potential and current vary. They are hardly practical cases, because electrical distribution is almost always either at constant current or constant potential. It is, however, of course possible to have cases where both may vary, and examples of each case are given.

Case 13 is one which does occur to a certain extent in practice; for example, if a so-called constant-current circuit varies slightly, as it always does in practice, say from 9 to 10 amperes, then the current as well as potential is variable to that extent, and this must be taken into account in the regulation.

In the experiments which I have already referred to, Mr. Wheeler and I have built a motor of the constant current type which will govern for wide variations in current as well as in load. This motor, for example, will not fall in speed, even though the current be reduced from 10 to 5 amperes, which is a great variation for this type of motor, as the field and armature being in series, the torque varies as the square of the current. This variation in current in the so-called constant-current circuits is a much greater percentage than the variation in potential of so-called constant-potential circuits and amounts to $\frac{1}{2}$ to 1 ampere.

Having generally described the different cases of motor regulation, let us take up the mathematical relations, current, speed and load, which may be expressed quite simply.

Using the symbols P C S and L as defined above, we have $P \times C$ as the total electrical energy supplied to motor in watts, or $\frac{P C}{746}$ in horse-power. Calling commercial efficiency a, the actual mechanical horse-power developed by a motor is $\frac{a P C}{746}$ expressed in electrical terms. The equivalent expression in mechanical terms is $\frac{2 \pi S L}{33000}$. Since the point at which load L is measured is 1ft. from centre of shaft and travels 2π feet per revolution, or $2 \pi S$ feet per minute, this, multiplied by the load and divided by 33,000, gives the horse-power developed by the motor.

Thus we have:—

$$\frac{a P C}{746} = \frac{2 \pi S L}{33000} = \text{horse-power of motor;}$$

or,

$$P C = \frac{746 \times 2 \pi S L}{33000 \times a} = \frac{S L}{7 \cdot 04 \times a}$$

For convenience we may write $P C = \frac{S L}{7 a}$ with an error of about one-half of one per cent.

If the efficiency a of motor is 85·2 per cent., the denominator, or 04 a, becomes 6 exactly, and we have $P C = \frac{S L}{6}$; and if the efficiency is 75·8 per cent. we have $P C = \frac{S L}{5}$. The former is as high and the latter is as low as is ordinarily met with in practical work; therefore these are the limiting values.

The equation $P C = \frac{S L}{7 \cdot 04 a}$, or one of the three simplified forms just given, may be advantageously used for solving problems in motor regulation. If we know any four of the quantities we may, of course, find the fifth by simply solving the equation with respect to it. It is also evident that if any three of the quantities are constant then the other two will vary directly or inversely with each other, depending upon their position in the equation. This is the ordinary case we have to deal with in regulation. Usually speed is required to be constant, either potential or current is maintained constant, and efficiency should be practically constant down to very small loads; thus we have either current or potential or load varying directly with load. The efficiency is rather a confusing element in motor regulation. For this reason it was not introduced as a fifth quantity in the second table, as it would have complicated it and made a great many more possible cases. The efficiency should be high (close to 100 per cent.) and as nearly as possible constant, therefore it would not affect the figures much.

If the load or speed is zero, or very low, the potential or current should be correspondingly reduced, and the efficiency would remain constant. This is the condition for perfect regulation. Practically it always takes some current to overcome friction, &c., even when load is zero, in which case efficiency is zero; but this current should be very small.

The equation $P C = \frac{S L}{7 \cdot 04 a}$, applied to the cases marked "not practical" in second table, shows in Case 4, for example, that if P C and L are constant, the efficiency a decreases directly with reduction in speed. This is not allowable. The same is true of the other cases, and shows that it is not proper to vary P C L simply at the expense of efficiency, or, in other words, waste current to obtain regulation.

Having now given the general points of motor regulation, we will consider the forms of motors which are now being used extensively.

First, and most important, we have the regular shunt motor for constant-potential circuit, which has already been referred to several times. Thousands of this type of motor are in use, and give very satisfactory results. A properly designed motor of this kind will regulate within 5 per cent., which is near enough for most purposes. It has no regulating mechanism or complicated circuits to get out of order, and it may be called the ideal self-regulating machine. The next important form is the differential-wound motor, which is even more perfect in closeness of regulation, theoretically, and it might be made almost absolutely constant in speed; practically the speed varies about 2 per cent.

These are the figures given me by the company who manufacture these machines in the largest quantity and of the most excellent workmanship. Sylvanus Thompson gives an example of one of these machines, which only varied $\frac{1}{2}$ per cent. in speed with a variation from 1·1 to 11·14 horse-power.

The rule for winding differential motors is that the number of turns in the shunt divided by the number of turns in the series coil are equal to the resistance of the shunt divided by the resistance of the armature plus the resistance of the series coil. On this side of the Atlantic this is called Sprague's law of winding; on the other side it is called Ayrton and Perry's rule for winding. The slight variation in speed which does occur is due to the heating of the two coils and other slight disturbances. This shunt coil varies considerably in resistance effected by heating; therefore the series coil should have a few less turns than the rule requires. The heating of the shunt coil weakens the current in it, and consequently the field magnetism, thus increasing the speed of the machine; therefore the motor runs faster after it has been running for some time. The proper way is, of course, to consider the true speed to be that which the motor has in steady running. At first some trouble was experienced in this type of machine on account of short-circuiting between the series and shunt coils, but this has been overcome by more perfect insulation.

The shunt or differentially-wound machines may be varied in speed by putting resistance in the field circuits, as shown in Fig. 1. This may, of course, be done automatically or by hand, usually the latter.

The next important type of machine is the constant-current motor. As already stated, this is merely a series-wound machine, with switch for cutting in and out the field-coils, the latter being operated by an automatic centrifugal governor, as indicated in Fig. 3, or by hand. Various modifications of this type have been made—for example, a reversed coil may be wound on the field-magnet coil and having a variable resistance in circuit with it. If this resistance is very high, the reversed coil has little or no effect. If this resistance is made very low it will rob the main coil of its current, and also neutralise its effect, thereby greatly reducing the strength of the field-magnet. All these motors with varying field strength have the drawback that a certain time is required for the magnetism to vary, and the regulation is therefore sluggish. If we

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attempt to hasten this by laminating the field-core we have sparking at switch points, due to self-induction in field-coils.

Constant-current machines with regulator are now in great demand for arc circuits; in fact, it is not practical or safe to use a motor on an arc circuit without a regulator, as the danger of racing away is very great.

The differential winding of constant-current motors to maintain constant speed is not practicable. The solution of it requires either that the efficiency should be very low or that storage batteries be used in connection with the motor to maintain a constant difference of potential. Any such plan as this is, of course, very objectionable.

The three types just given are really about the only continuous-current motors used to any extent in practice, and it seems that there is at present no demand for any other type.

Nothing has been said of the regulation of alternating-current motors, because it is a radically different subject, and, moreover, alternating-current motors tend to run synchronously, maintaining a constant speed and regulating themselves.

In conclusion, I would say that I would like to see this subject taken up by leaders in electrical science.

RELATION BETWEEN THE INITIAL AND AVERAGE EFFICIENCY OF INCANDESCENT LAMPS.*

At the recent meeting of the American Institute of Electrical Engineers an able Paper upon the above subject was read by Mr. W. H. Peirce, who has carried out a careful and elaborate investigation into this question on behalf of the Chicago, Burlington and Quincy Railroad Company. We regret that the space at our disposal will not permit us to give Mr. Peirce's Paper at full length, together with the numerous diagrams which accompany it. Fortunately, however, the final result arrived at is adequately presented in the four diagrams which we reproduce on an enlarged scale. Mr. Peirce commences with the remark that "At the present day there is very little reliable published information relative to the variation with age of the economy and light-giving power of incandescent lamps." The methods adopted in making the electrical and photometrical measurements and required tests are fully described in the Paper, and we think there can be little doubt as to their suitability or as to the care and skill with which the tests were carried out.

Measurements of candle-power and efficiency were repeated for each of 94 lamps (supplied by four different makers) after a life of 55, 110, 200, 300, 400, 500, 600, and 800 hours respectively. The results are embodied in the subjoined diagrams and tables, which are explained by Mr. Peirce in the following terms:—

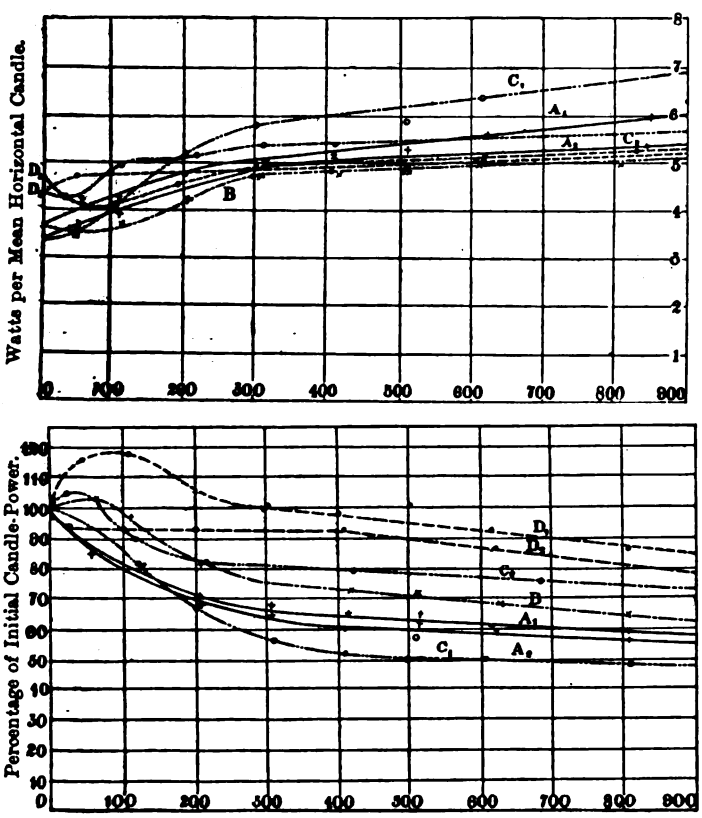
"In the accompanying curves each make of lamp is designated by a letter. A_1, B_1, C_1, and D_1 have reference to the purchased lamps; A_2, C_2, D_2 indicate those tested at the request of the lamp companies. In either case similar letters refer to like make of lamps.

"In the first of these (Plate 1) is shown the variation with age in the economy and candle-power of all the lamps. Each curve represents a batch of from 10 to 15 lamps; thus the C_1 lines relate to the 15 lamps purchased, and the C_2 curves indicate the influence of life upon the lamps contributed by the *C* lamp company.

"The upper set of curves illustrate the economy of the several lamps at their different periods of life. Thus the A_1 curve indicates that these 15 A lamps when new consumed 3·54 watts per mean horizontal candle, that after 900 hours 6·1 watts of electrical energy were necessary to produce one candle-power of light, and further that during 900 hours the mean economy of the lamps was 5·25 watts per candle-power.

"The lower diagram indicates the effect of age upon the light-giving power of the lamps. Thus the A_1 curve demonstrates that these A lamps after 900 hours gave but 58½ per cent. of the initial candle-power, and that the mean intensity of light during 900 hours was 67 per cent. of the new lamps. . . . .

PLATE I.—Curve of all Lamps showing Variation in Economy and Candle-Power with Life.



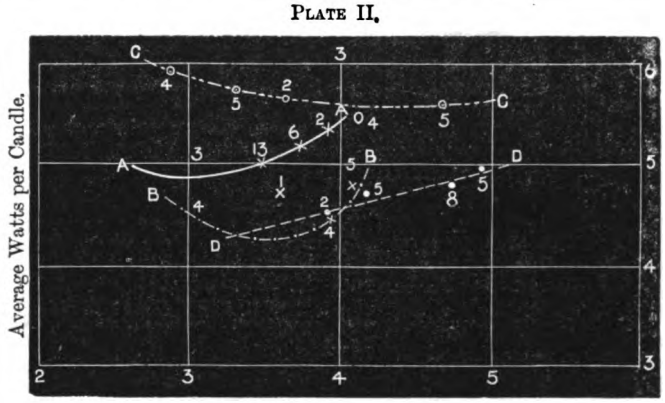
A_1	Average watts per candle	5·25
A_2	" " "	4·83
B_1	" " "	4·58
C_1	" " "	5·80
C_2	" " "	5·36
D_1	" " "	4·92
D_2	" " "	4·92

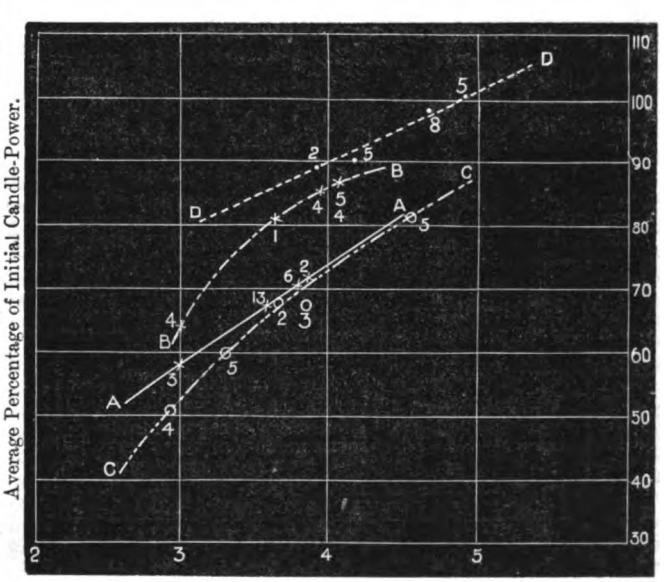
Average Percentage of Initial Candle-Power.

A_1	Average per cent.	67
A_2	" "	64
B	" "	77
C_1	" "	60
C_2	" "	82
D_1	" "	98
D_2	" "	90

* A Paper read before the American Institute of Electrical Engineers New York, 1889.

PLATE II.





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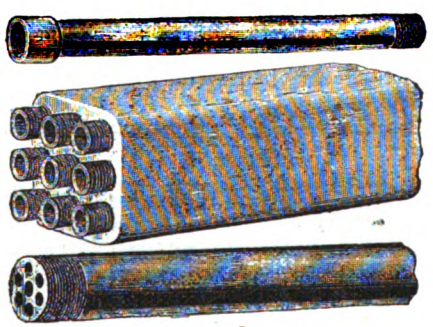
"In the second series (Plate II.), we have a summation of all previous diagrams and tables. These curves show the relation between the initial and average efficiency of the incandescent electric lamps studied. These curves are plotted with the initial economy of the lamps as abscissæ, and the corresponding averages deduced from the preceding curves as ordinates. The figures at the plotted points have reference to the number of lamps used in determining each point.

"From these curves we learn that the varying of the initial economy between the limits of 3 and 5 watts per candle does not greatly affect the average economy, but it does have a very marked effect upon the average candle-power derived from the lamp."

THE MEDBERY UNDERGROUND SYSTEM.*

Undoubtedly the most serious problem that is agitating the minds of electricians at the present time is that of laying electric light and power distribution wires underground in a safe, economical and durable manner.

Many systems and plans have been devised to accomplish this result, and while many of them are meritorious and deserving of attention, nothing has been found that successfully accomplishes the desired results. The chief difficulty has been the inability to guard the wires properly from contact with the conduit or from gases and moisture. It has also been found difficult to provide a system that will protect human life without great and expensive outlay. An ideal system, moreover, must combine extreme durability with ease of laying and distributing for house and street lighting and power.



Figs. 1, 2 and 3.—The Medbery Underground System.

The system which we now call attention to consists of one or more tubes made from wood fibre and treated with a chemical compound which renders it water and fireproof. The material is not subject to deterioration by the action of acids or gases, but is of great strength, practically indestructible, and not subject to decay when placed underground. The sections are joined by threads cut in the pipe, like iron pipe, and with a sleeve coupling. At the manholes the pipes do not terminate as in other subways, but continue directly through with a collar which can be unscrewed when necessary to reach the cables or wires. Hence gases and moisture cannot get into the pipes. For all underground wires this advantage is of great value, as explosions cannot occur as they have done with existing methods and material. This system is especially desirable for telegraph and telephone wires, and is highly commended by several of the largest corporations in the country.

The conduit for light and power wires and system of distribution, which is shown in perspective in Figs. 1, 2, and 3, combines several new and valuable features. Each "conduit" is divided into four or more compartments, made of a perfect insulating material, and the wires occupy separate ducts, which precludes the possibility of "cross arcs"; and in the event of a "misplaced" switch at the station, and the "positive" current being turned into the "negative" conduit, no harm nor damage can ensue. The question of the cost of properly insulating wires is one of considerable importance. The expenditure is necessarily very great in the ordinary method of laying wires; but in this conduit, by reason of its high insulating qualities, expensive insulation of wires is avoided.

Another noteworthy feature of this system is the method of distributing to houses and street lamps. Usually it is necessary to make provision for this when laying the conduit, which is necessarily very expensive; but by this system side taps and connections can be as easily made *at any time* after the conduit is laid, and without serious expense, as will be seen from the accompanying illustrations, Fig. 4 and 5.

* From the *Electrical World* of New York.

When desiring to make connection with the main line, the conduit is exposed at any point, and an opening is cut in it in any preferred manner. It is usually drilled. The wire is then lifted from its resting place in the conduit, through the hole in the conduit, and the two parts of the metallic clamp G being first separated are put over the wire and firmly attached thereto by means of a screw. The clamp has a chamber into which a suitable metal or solder is melted or fused, making a perfect contact and permanent joint. The two sides of the casing or connecting box (which, it will be seen, has a recess or hollow interior) may be filled with suitable insulating cement while in a plastic state, and they are then placed about the conduit in such a manner that the extension of the clamp H projects through the neck of the casing, as shown in the cut. The bolts are then inserted in the lips of distributing duct B, and screwed up. The cap C is then applied and forced firmly down upon the tapering neck of the casing, after being properly cemented.

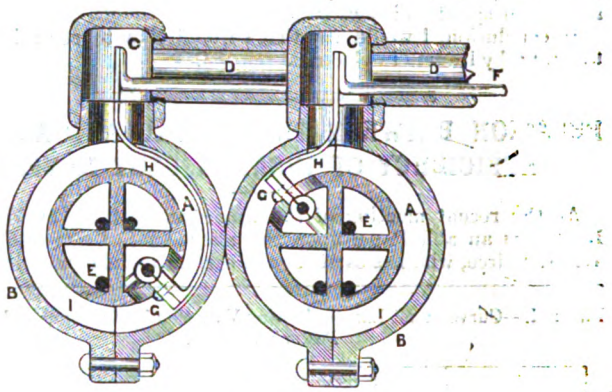


Fig. 4.

The branch wire is then connected with the extension from the clamp H, and when it has been passed through the first length of the branch conduit F, the branch conduit is screwed into the threaded hole in the side of the cap C, or preferably cemented into place. The branch line can thus be extended as far as may be desired. Thus far in the process connection has been made with one wire only, either the negative or the positive wire; but, of course, the connection with the other wire will be made in a similar manner.

After both connections are made and all parts are secured in place, the entire device is enclosed in a mass or ball of hydraulic cement, as indicated in Fig. 2, which will solidify and protect the parts from accident or injury from tools of workmen in subsequent excavations.

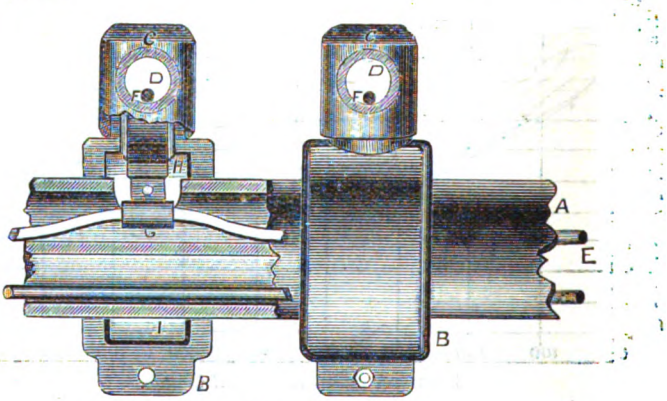


Fig. 5.

The advantages of this system over any other are apparent, as the main conduct can be opened at any time, and connection made in a very easy, expeditious and inexpensive manner, and is not restricted to any defined place, as under the old method. This is a matter of great importance in cities where gas, sewer, water, and other pipes or conduits frequently interfere with, if not preclude, access to the conduit at the points where the connection boxes should happen to be located.

The system as above outlined is being introduced by the American Indurated Fibre Company, of Mechanicville, N.Y. It may be mentioned that satisfactory practical work with it has been done by the Bell Telephone Company, of Philadelphia; the Pennsylvania Railroad Company, and others.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June* 8, 1889.

During the present week the financial and speculative world of New York has practically been in a state of suspended animation, owing to the absolute and complete cutting off of the "ticker" service from the floor of the Stock Exchange by the Governing Committee of that body. The action was taken very suddenly, and does not appear to have been expected up to the 1st inst., when the contracts of the Stock Exchange with the Gold and Stock Telegraph Company and the Commercial Telegram Company expired. It seems to have been generally supposed that those contracts would have been renewed, but at the last moment the Committee determined to discontinue the ticker service without warning, and it did so, although it had made no provision for resumption or for the substitution of any other service that would be equally expeditious and efficient. The main object of this action on the part of the Governing Committee was to deprive the "bucket shops" of their quotations. There have been various rulings from time to time on the question whether the quotations, as made on the floor of the Exchange, belong exclusively to that body or are public property, and the result of the litigation has been that the Exchange has been required not to discriminate between the rival ticker companies, and that the ticker companies in turn have been required not to discriminate between their customers; so that as long as the Stock Exchange allowed the quotations to go out over the ticker wires the "bucket-shop" proprietors obtained them just as freely and as fully as anybody else. Now, it might seem to be a little below the dignity of so large and wealthy and powerful a body as the New York Stock Exchange to take such extreme measures against people whose business has been more than once stopped by the officers of the law as gambling of an illegal and pernicious nature; but to the Committee and to most of the brokers there appeared to be no other way out of the difficulty, and from time to time the advisability of keeping back the quotations altogether has been very seriously discussed at the Stock Exchange, for the reason that, however small and mean as opponents, the bucket shops individually might be, the amount of business done by them is in the aggregate enormous, and has the effect of diverting from the Exchange a great many orders that would otherwise find their way there. It is estimated that there are throughout the country about 5,000 bucket shops, where, daily, clerks and messenger boys and humble men with very small means, gamble in small lots of shares at correspondingly small risks. If each of the bucket shops averages 200 shares a day, their total business each day would amount to one million shares of stock, and in all probability it rises to a much higher figure than that. It appears that for the four full business days of last week the average sales on the Stock Exchange amounted only to 387,540 shares. From these statistics it may be gathered that the diversion of business was by no means insignificant. Another reason for the smallness of the business lately done on the Stock Exchange is the fact that a younger body, known as the Consolidated Exchange, has lately extended its operations from oil and mines to telegraphs and railroads and the other securities dealt in on the Stock Exchange, and this again has served to cut down patronage enjoyed by the brokers of the older and more conservative body. It is claimed by the Governing Committee of the Stock Exchange that their action in silencing the tickers was aimed solely at the bucket shops, but it is not unlikely that the Committee may also have had the Consolidated Exchange in view. Anyhow, the blow was struck, and on the Stock Exchange the brokers, in default of any substitute for the ticker service, had to fall back on the telephone and the old method, known as "pushing the pad," which consists in scribbling the quotations on a pad as fast as a sale is made on the Exchange, and sending off the slip at once by messenger; but while the brokers have been restricted to these crude devices, and have been grumbling at it in a resigned sort of way, the bucket shops, while at first they staggered under the blow, have "bobbed up serenely," and now seem to be doing as much business as ever. In several of the bucket shops this week the tickers have been reeling off their quotations on the tape in the familiar manner, and, as far as could be ascertained, the prices were pretty nearly correct. At the Consolidated Exchange the brokers began making their prices independently of whatever business might be done on the Stock Exchange, and it is asserted that the experiment has proved a success. The Consolidated Exchange has, moreover, a separate ticker service of its own operated by the Stock Quotation Company, which, owing to the crippled condition of its competitors, the Gold and Stock and the Commercial Telegram Companies, has been doing a rushing business.

While this action of the Stock Exchange has caused a tremendous sensation, it cannot it appears be considered altogether a success, and there are rumours already that the Exchange has in view the establishment of yet another ticker system of its own. There appears to be some foundation for the report, but the matter is kept extremely secret, and nobody knows just what the new system is likely to be. The fact that the Governing Committee already finds it necessary to promise some substitute of this kind shows how imperative is the necessity for the ticker service. In view of the magnitude of the public interest involved in the quotations made on the floor of the Exchange, the public and the Courts have been slow to recognise that the Exchange has any vested and exclusive right in such quotations; and it stands to reason that those who are interested in the movements of the Stock Market, as hundreds and thousands are every day, to say nothing of those bent on speculation, will find it impossible to make the laborious journey to the nearest broker's office whenever they wish to ascertain the current price of some of the stocks. In fact it is out of the question that such people should make long journeys to offices in the neighbourhood of the Exchange, and it is also evident that unless they do so, so long as mere memorandum pads are used, supplemented by slow-footed messengers, the offices nearest the Exchange would have a vast and unfair advantage over those which happened to be a little further removed. The ticker service equalised all these conditions, and its resumption on as large a scale as ever may be early expected. The same may be said of other cities like Chicago, where similarly abrupt and extreme action has been taken. In Chicago, in connection with the dealings in grain, several of the commission men reported that some of their customers who could not secure continuous quotations said that they will not trade at all unless they can be furnished with them, so that the action of the authorities is already developing some unpleasant boomerang characteristics.

You will remember that a few weeks ago I described in this letter the Williams "portelectric" system of transportation, the *modus operandi* of which consists in sucking a carriage through a succession of electro-magnetic helices mounted on posts and girders, like an elevated railroad. The system was exhibited in New York for a time, and is now being shown in Boston, where its ingenuity is attracting a great deal of attention. At this stage, however, Dr. Henry Wurtz, a well-known chemist, comes forward with a letter in the *Engineering and Mining Journal*, making claims to have devised a similar system as far back as 1860, at which time, being then an examiner in the Patent Office and not entitled to take out patents, he placed his Paper in the hands of Prof. Joseph Henry, at the Smithsonian Institution. His apparatus he proposed at that time to call the electro-magnetic tachyphore. Prof. Henry, Dr. Wurtz states, regarded the invention as then highly premature, and as one which was scarcely likely to be valuable in our day, both because there was not an adequate source of current and because the public had not grown up to the necessity for such a method of transportation. Dr. Wurtz states that at a later date, when no longer in the Patent Office, he recurred to the subject, and then became aware of the existence of two prior British patents, Nos. 58 and 514 of 1862, one issued to Bonelli and the other to H. W. Cook. Both these patents, it is true, like Dr. Wurtz's idea, seemed to come tolerably near the main device or principle, although Bonelli's feature of carrying a battery on the vehicle would seem to present insuperable objec-

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tions. Here, then, we have another of the anticipations which beset the ingenious and aspiring inventor of to-day, and the question once more arises how far these anticipations, which amounted to nothing and never did anybody any good, should be allowed to stand in the way, and operate to the detriment of the later inventor, who, seeing the necessity of the times, has brains and energy enough to carry the idea to completion and perfection. I do not now propose to discuss the relative merits of the inventions of nearly thirty years ago, and of that which Mr. Williams is now introducing to public notice as the portelectric system. I have no doubt that there are many features in Mr. Williams' system peculiar to it, and upon which he has good patents; and if there be anything of merit in his invention by means of which the transportation of mail matter and the parcel delivery can be expedited, I for one should be very glad to see it successfully exploited.

A very interesting statement has been published this week as to the cost of operating electric railroads in this country. The tests in question have been made on the Daft-road, using the overhead system at Asbury Park, one of our popular seaside resorts in New Jersey, and were carried out by Mr. F. E. Idell. At the time that the tests were made, there were 14 cars running on the road. The conditions were by no means favourable to the showing of high economy. There were, for example, three engines of a total 180 horse-power, developing a maximum of 120 horse-power, while the average horse-power for the two days' run was less than one-half their normal rating. Of course the economy could not be as great as if they had been running on full load. Another point was that the steam-piping was large enough to supply double the engine capacity, and that it was, moreover, uncovered. In spite of such material drawbacks as these, Mr. Idell determined that at the place named the cost of motive power for operating the 14 cars from 17 to 18 hours per day is $3.13 per car, which, of course, would be considerably reduced if the number of cars were increased. The figure that I have given includes interest and depreciation on cost of the power plant, the overhead system and the motors, the wages of the two engineers and two firemen, coal, oil, waste and water. If the number of cars were increased to 20, the cost of the motive power would fall to about $2.68 per day. Now, when operating the 14 cars by animal power, at least 140 to 200 horses would be necessary, and the average cost of keeping these in this country would be 50 cents a day, or a cost of $5 per day for a car, to which must be added the interest on the investment in the horses themselves and in huge stables, running the figure up to at least $6 per day per car. This, of course, is taking the road under normal conditions of active operation. In winter the advantage is still more in favour of the electric road, as the output of power is then strictly proportionate to the lessened work being done, whereas if animal power were used the horses would have to be sold at a great reduction, or else kept all winter eating their heads off. Then, when the summer came round again, if they had been sold new stock would have to be bought at a high price. Mr. Idell's Paper did not include any electrical measurements, but simply took the cost of delivering the current to the motors, but that is enough, as a general thing, to satisfy railway managers inquiring into the subject.

I need hardly go into details regarding the awful disaster at Johnstown, Pennsylvania, last week, as by this time every newspaper in the civilised world has contained some account of the manner in which the Conemaugh Lake burst its banks and swept down the narrow valley, destroying towns and hamlets, and drowning thousands of the industrious inhabitants. The incident has caused a most painful sensation throughout the country, and every community is hastening to mitigate the horrors of the occasion by contributing freely to the various relief funds that have been started. One of the striking features of the incident was the suddenness with which unfortunate Johnstown was cut off from communication with the outer world. The manager of the local Western Union Company was a lady, Mrs. H. M. Ogle, who died at her post in a most heroic manner. In spite of repeated notifications that she must get out of reach of danger, and at a time when the swollen waters were already beginning to rise rapidly, she refused to leave the instruments, and went on sending warnings down the valley. When every office in the path of the coming current had been warned the huge wave was upon her, and with her sad words, "This is my last message," all communication between Johnstown and the outer world ceased. This is an example of heroism which matches that of the little telephone girl who kept at her post at Jacksonville, Florida, all through the last yellow fever epidemic, and by her work did much to assist in saving the sick and burying the dead. Reports from Johnstown show, as your readers are doubtless aware, that the whole city has practically been wiped out of existence. The telephone exchange and the telegraph office have gone, and nothing remains of the fine Edison plant of 5,000 lights which had been in operation successfully for three or four years.

Since I wrote the first part of my letter, two or three days ago, there have been further interesting developments in the ticker matter, with the result that the voice of the ticker is heard in the land once more. So far as can be gathered from what has been made public, the Stock Exchange policy has led to an understanding between the two regular quotation companies, which hereafter are to work in harmony. The instruments of the Gold and Stock Telegraph Company are to be supplied to regular members of the Exchange, while the general public will be furnished with the instruments of the Commercial Telegram Company, which, it is said, will send out its quotations one or two minutes after those of the Gold and Stock Company, so that while the public will still get its information, it will have to go to the office of a regular member of the Stock Exchange if it wishes to get that news promptly. Moreover the rent of the instruments is to be advanced from $10 a month to $25, and the instruments of the Commercial Company will only be furnished to persons of whom the Stock Exchange approves. In such way, it is believed, fondly but foolishly, that bucket shops will be prevented from obtaining their quotations. It is popularly rumoured that this arrangement would not have been effected if Mr. Gould had not threatened to cut the Stock Exchange off absolutely from all telegraphic communication whatsoever. Prominent officers of the Stock Exchange deny this story very emphatically, as they do also the statement made as to the arrangement, but their denials may be taken largely in a diplomatic sense. As to the effect on the bucket-shops, it is perfectly safe to say that under this new arrangement they will have their quotations just as soon as anybody, and much sooner than those who are dependent on the service of the Commercial Telegram Company. How this arrangement, moreover, is likely to suit the Commercial Telegram Company it is not easy to see. They may find a salve for their wounded pride in a steady and assured income at the higher rates, but hitherto it has been their boast, and with some show of reason, that they could whip the Gold and Stock Company out of their boots. Perhaps they may consider their end gained when Mr. Gould thus admits them to partnership.

BERLIN NOTES.

(FROM OUR OWN CORRESPONDENT.)

June 16, 1889.

The Electrical Section of the Berlin Safety Appliance Exhibition cannot be said to represent the present state of the industry in Germany, as many leading firms are not exhibiting at all, while others show but a small part of the apparatus they specially manufacture.

The Deutsche Elektricitäts Werke (Garbe, Lahmeyer and Co.), of Aachen, represented by the firm of Erfurth and Sniell, Berlin, exhibit two dynamo machines of the well-known Lahmeyer type, driven by belting from a Westinghouse engine. This plant, which is placed in the Machinery Hall, exhibits Herr Lahmeyer's interesting distributing system in action. The main dynamo machine, which is compound-wound for 270 amperes and 110 volts, is connected in series with a small series-wound regulating dynamo machine, which gives an E.M.F. of 24 volts. The system, which has been described in *The Electrician*, is already being used in a central station at Bostock, where the regulation is found to be exceedingly perfect; but the details of construction of the machines and switch-board are not sufficiently novel to merit special description.

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Amongst machinery not in motion, Herr Schuckert, of Nurnberg, exhibits a dynamo coupled direct on to an engine of the type produced by Herren K. and T. Möller, Brackmede, and standing on the same bed-plate. At the high pressure used for marine engines, the plant being specially designed for ship work, the engine gives 16 horse-power; it has two cylinders, which makes it run exceedingly smoothly, and is considered a distinct advance on the central-valve engines hitherto made. Owing to the small weight and space occupied by this plant, as compared with its capacity, the requirements of the navy are fully met by it.

The dynamo machine is shunt-wound; the field-magnets consist of a vertical cast-iron ring, with eight poles pointing radially towards the armature, which is of the drum type, having an output of 150 amperes and 70 volts when running at 550 revolutions per minute. There are twenty-four connections to the commutator, every four bars of which, at an angular distance from one another of 90deg., are coupled in parallel, so as to require only two brushes, which, however, for practical reasons are separated by 135deg. instead of 45deg. On the switch-board are a rheostat for the dynamo, a strong double-pole switch, a voltmeter, and an ammeter specially designed by Hummel for use on shipboard. The weight of the engine and dynamo together is 1,700 kilos., that of the dynamo alone 830 kilos. The weight of copper on the armature is only 14 kilos., and of that on the field magnets 88·5 kilos.

The most interesting part of Herr Schuckert's exhibit consists of his projector lamps—one designed to work with 60, another with 150 amperes. A great number of these projectors have been supplied to the home and foreign armies and navies, and are claimed to be the best yet constructed. An electric motor gives the projector its movement in both the vertical and horizontal planes by moving a switch. The vertical motion is limited, but the projector can be swung right round in the horizontal plane, the current passing through strong circular contact springs. The arc can be placed in the exact focus of the parabolic reflector by the aid of a piece of silvered glass with scale, and is kept in position by means of an electro-magnetic contrivance, so as to prevent ascending currents of air carrying it against the upper carbon, and causing it to burn away irregularly. The parabolic mirror is said to be the most perfect yet constructed, for although 960 millimetres in diameter, it is of uniform thickness throughout. The method of manufacture of these reflectors is patented by Herr Schuckert. To stop vibration, the reflector is mounted on an iron frame covered with layers of asbestos, and held in position by a number of smooth copper springs. In the front of the lamp case is placed a disperser, by means of which the rays of the lamp can be made parallel, or dispersed horizontally, so as to make a beam of light, whose angular breadth is 45deg. The opening of the lamp is ordinarily protected by means of glass strips of suitable breadth, but it may also be entirely closed by the addition of a venetian blind arrangement if a signalling light is required. The arc is regulated by two electro-magnets, one of which strikes the arc, the other, placed in shunt with the main current, controls the movement of the carbons.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *June* 12, 1889.

Ischl, the well-known beautiful health resort in the Salzkammergut, is now to have the electric light. The Town Council have bought the Traunmill, which they propose using as the motive-power for the proposed installation, the water-power being very considerable.

Trient will be lighted entirely with electricity by the end of this year. The motive-power will be water, 600 horse-power being available for the purpose.

The lighting will be done almost entirely by glow lamps. The price proposed is 50 kreutzers a year per candle-power. In order to show the citizens the advantages of the electric light and of electricity as a motive-power, the Town Council have opened an Exhibition showing the use of the electric light in every form, in the house of the rich and in the cottage of the working man, also the use of the electric current for driving machinery in a private house and in the workshop. Over 1,000 lamps have already been subscribed for by the inhabitants.

The electric installation in Marienbad will be opened this week, as already reported. This installation has been carried out by Messrs. Ganz and Co.

The shares of the International Electric Company, promoted, as reported, by Messrs. Ganz and Co. and the Union Bank, have been issued. The issue was a great success. The company's capital is 3,000,000fl., or about £250,000, divided into 15,000 shares of 200fl. each. They were issued at 240fl., or 20 per cent. premium; 300 were reserved for the directors, 4,800 for Messrs. Ganz and Co., so that 9,900 were issued. These were over-subscribed for nearly *a thousand* times in Vienna, Frankfort, or Budapest. For years nobody would subscribe anything to electric or telephone companies in Austria; now suddenly the mania seems to have bitten Continental or rather Austrian capitalists, and they have subscribed to a company which, up *to date*, has really only a few patents to work on. There is, however, a great field open for electric enterprise in Austria, and English capitalists would do well to try and share the field. Austria is a country capable of infinite development, having very little capital, and much can be done here by judiciously investing capital and with honest work.

The Union Bank has also undertaken the issue of the new capital of the Vienna Telephone Company. This will also be issued at a premium, and amounts to nearly £150,000. The number of subscribers in Vienna is increasing rapidly; cables are being laid for 3,000 more. In the large provincial towns much activity prevails. These belong to the Telephone Company of Austria. The number in these worked by this company now amounts to over 2,600. Over 60 stations and lines are given by the company, free of any charge, to the fire brigades, hospitals, and other charitable institutions.

The telephone is largely used in Austria by the fire brigades, especially by the volunteer fire brigades in the smaller towns. In Bielig, for instance, a large bell has been put up in the company's tower. As soon as a fire is reported to the telephone central station, the head officer of the fire brigade is called, and the bell rung by turning a switch, thus calling together the members of the volunteer fire brigade. The company's system of lightning arrestors has proved itself very good.

The thunderstorms this year have been terrific. On May 21 a great storm took place in Richenberg, and many houses and factories were damaged, but not one where the telephone wires crossed, and it is believed that they must have prevented much damage. For a long time the central station was not put to earth in order to enable any fire reports to reach the fire brigade; three such reports were received, and the speed with which the messages were delivered and the fire brigade appeared prevented the fire taking hold.

In the end, however, it was impossible to work any longer, all drops falling together, and the office had to be grounded. In spite of this storm only comparatively little damage was done. Out of 330 stations only about 20 coils were burnt and about 22 drops injured.

COMPANIES' MEETINGS & REPORTS.

Submarine Telegraph Company.

An extraordinary general meeting of the Submarine Telegraph Company between Great Britain and the Continent of Europe (Limited) was held at the offices, Throgmorton-avenue, London-wall, on the 19th inst. The chair was occupied by Sir Julian Goldsmid, Bart., M.P.

The SECRETARY (Mr. S. M. Clare) read the notice convening the meeting.

The CHAIRMAN: I have very little to say to you to-day. I informed you last time that we had to call these two meetings in order to satisfy the requirements of the solicitor of the Post Office. I think that when we have completed this meeting to-day we shall have done all they have demanded of us, and that therefore, as far as they are concerned, we shall be able to finish all the arrangements we have to make with them. You all know probably that we have realised the reserve fund, and that that realisation has already produced a distribution of assets among the shareholders, as you have received your warrants for 75 per cent. of the capital of the Company. The realisation of the reserve fund has been a satisfactory one. I think it shows that we made fair investments on behalf of the Company, because those investments have realised about £28,000 more than they originally cost us, and consequently in that respect I think we can have no complaint to make. We have further to receive now, as soon as the Post Office is ready to pay us, the sums they have to pay for the purchase of the cable, for this house, and so on, and we have also to receive the money from the Paris and New York Company which they have to pay us for our half share in the Deolen cable. Then, subsequently, we shall have only one more matter to complete—that is, to come to some arrangement with the Anglo-American Company as to the Salcombe cable. That, I am afraid, will be the longest matter we shall have to deal with, and it will, therefore, delay the final realisation of the assets of the Company. We shall, however, do all we can to press forward a settlement, but you will understand that when these other bodies are concerned matters do not depend on us. I shall be ready to give you any further information I can, but meantime the motion I have to propose is as follows:—

"*That the Company be wound up voluntarily, under the Companies' Acts, 1862 and 1867, and that Sir Julian Goldsmid, Bart., M.P. (the Chairman of the Company), the Hon. Henry Robert Brand (one of the Directors), and Mr. Stephen McDonnell Clare (the Secretary), be and they are hereby appointed liquidators for the purpose of such winding up.*"

I have to propose that as a confirmation of the resolution passed at the previous meeting.

The Hon. ASHLEY PONSONBY seconded the motion.

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The CHAIRMAN put the resolution in the usual way, and said: No poll is demanded, and I declare the resolution carried. Continuing, he said: It was discussed at the first meeting we held some time ago on the subject of the liquidation what payment should be made to the liquidators, and I then stated that I thought the best plan would be for their remuneration to be settled at the final meeting. If you approve of that suggestion, it would be well that you should pass a resolution to that effect. Perhaps Mr. Carmichael will move it.

Mr. CARMICHAEL: I will move

"*That the remuneration of the liquidators be settled when they present the account of the liquidation.*"

Mr. KING seconded the motion, and expressed the hope that the expenses of the liquidation would be made to fall as lightly as possible upon the shareholders—he referred to the payment to be made to Sir Julian Goldsmid and his co-liquidator. As a matter of pay for services rendered, the sum might be a substantial amount; but he thought he need hardly appeal to those gentlemen, in the circumstances of the case, to make the expenses as light as possible, as it would be a kind and gracious act to do so. His remarks did not apply to Mr. Clare, the secretary, who, as they knew, was the person upon whom, in such matters as these, the weight and burden of what had to be done would fall. He had made the suggestion in the interest of many lady shareholders. He felt that an uncommonly shabby settlement had been imposed on the Company by the Government, who were acquiring a magnificent property from those who had had the enterprise to initiate it. He thought that the country in the end might find that the Government had overstepped the mark, as such proceedings were precedents; but in the meantime the shareholders had no redress. They were at the mercy of the Government, who had chosen to squeeze them most unmercifully.

A SHAREHOLDER inquired if the Company would participate in the earnings of the first three months of the current year?

The CHAIRMAN: I am quite sure that neither Mr. Brand, nor Mr. Clare nor myself would wish any undue payment to be made for any work we do with respect to the liquidation, but I do not think it would be fair or right that it should be done without remuneration. It is the regular practice in these matters, but we shall not ask for anything unreasonable. I stated at the first meeting that among the assets for the liquidation would be the proceeds of our share of the earnings for the three months ended March 31 last. These accounts are now being prepared, but they have to be submitted to a variety of persons. He then put the motion, which was carried.

A SHAREHOLDER: What do you suppose the shareholders will receive, leaving out of consideration the matter to be arranged with the Anglo-American Company?

The CHAIRMAN: I told the last meeting that we should give them something over par. That amount will be something between 105 and 110; but I cannot say definitely, until we settle with reference to the Salcombe cable and as to the expense in the preparation of the accounts of the liquidation and a variety of other matters. In answer to other questions, he added: I told the shareholders at the last meeting that I hoped within a fortnight or three weeks that we should distribute a great part of the assets of the Company. We have already done so, in anticipation of this meeting. We posted 75 per cent. to the shareholders yesterday, and that money will be paid forthwith. As soon as we have the money in hand to justify our paying a further considerable amount we shall do so. I have been pressing Mr. Clare from day to day to push forward this matter. It does not, however, depend on him alone, but on the Government, who have to pay us, and on other persons. I am certain we shall be only too glad to give you as much more as we can on account, and the final payment will depend on the closing of the accounts. These premises have been valued by a competent valuer appointed by the Government and ourselves. The Government thought he had put them too high, and we said he had them too low; but if you ask me for my independent judgment, I should say he fixed a fair value.

Mr. KING then proposed a vote of thanks to the Directors for the way in which they had administered the affairs of the Company for so many years, and expressed regret that such service must now end.

The motion having been seconded and adopted,

The CHAIRMAN briefly replied, and the meeting then separated.

German Union Telegraph and Trust Company, Limited. (*In Liquidation.*)

A general meeting of the members of this Company was held at Winchester House, 50, Old Broad-street, on the 17th inst., "for the purpose of having the liquidators' accounts, showing the manner in which the winding up has been conducted and the property of the Company disposed of, laid before them, and of hearing any explanation that may be given by the liquidators; and also to determine by extraordinary resolution the manner in which the books, accounts, and documents of the Company, and of the liquidators thereof, shall be disposed of." The chair was occupied by Sir James Anderson.

Mr. WILLIAM PAYTON read the notice convening the meeting.

The CHAIRMAN: Gentlemen, before moving the resolutions I will just make one or two observations. Naturally the shareholders are disappointed at not receiving a larger sum of money for their shares, or such sum as we held forth as probable a year ago; but the irony of fate has been very hard upon us—so much so that since we sold the cable to the German Government, and before they took over its working, we had two breaks which cost £13,000, just £1,400 less than the repairs of the whole previous 17 years. That is very hard upon us, but there is no help for it. We have distributed all the money we received, and thus ends finally the German Union Telegraph and Trust Company, which has been very useful to the German Government and the public. I am bound to say that the German Government have used us better than our own Government has treated the Submarine Telegraph Company, and if the cables are going to fall into the hands of Governments I hope they will be dealt with in about the same way as we have been, or a little better, I hope. There now only remains, with great regret on my part and on the part of the Directors, to move the final winding-up of the Company. This meeting is called in pursuance of the Winding-up Act. The first resolution I have to propose is as follows:—

"*That the liquidators' accounts, submitted to this meeting, showing the manner in which the winding-up of the Company has been conducted and its property disposed of, be received and adopted.*"

You have had the whole statement in your possession for a month, and the money has been paid, except to a few shareholders who are absent out of town.

Count O. VON REICHENBACH seconded the resolution, which was carried unanimously.

The CHAIRMAN: The next resolution is as follows:—

"*That the books, accounts, and documents of the Company and of the liquidators thereto be retained by the liquidators, with authority to them to destroy the same after the expiration of one year from the dissolution of the Company.*"

Count VON REICHENBACH seconded the motion, which was unanimously agreed to.

The CHAIRMAN: That is the whole business of this meeting, and the German Union Telegraph Company is practically dissolved and buried.

Mr. WELLS: We are not a very large body of shareholders, although one can quite understand that this is not a very pleasant occasion to assist at—the decease of a Company like this which has given us a certain amount of profit. I think, however, that we are indebted to the liquidators

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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for the very prompt manner in which they have distributed the assets of the Company, and I therefore beg to move that a vote of thanks be given to Sir James Anderson and Mr. Payton for their services.

Mr. J. D. PENDER seconded the motion, which was carried unanimously.

The CHAIRMAN: We are very much obliged to you, gentlemen. We are very sorry to see the disappearance of a healthy company, but we must make the best of the position.

The meeting then separated.

The South of England Telephone Company (Limited).

The following is the report of the Directors of this Company for the year ending 30th April last, to be presented to the shareholders at the sixth ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, London, E.C., on Thursday, the 27th inst., at one o'clock :—

The expenditure on capital account for the past year amounts to £19,917. 12s. 6d., bringing the total of that account to £64,301. 19s. 2d. The revenue account shows a sum of £16,722. 2s. 4d. for subscriptions and rentals, and a net credit balance of £5,283. 9s. 11d., making, with the sum of £1,115. 0s. 8d. brought forward from last year, an available balance of £6,398 10s. 7d.

After providing for the preference dividends (£2,771. 9s. 5d.) which have been paid, a balance of £3,627. 1s. 2d. remains, out of which the Directors recommend the payment of a dividend on the ordinary shares of 1 per cent. for the year, free of income tax, which will absorb the sum of £3,000, leaving a balance of £627. 1s. 2d. to be carried forward.

The claim of the United Telephone Company for surplus instrument royalty and rent of the Brighton Trunk line, which was disputed by this company, has been settled.

The report gives a list of the completed Trunk lines, and announces that the following Trunk lines are in process of construction :—Canterbury—Deal ; Brighton—Hurst ; Faversham—Sittingbourne ; Brighton—Newhaven.

At the 30th April of this year, 1,901 exchange lines and 480 private lines were completed ; and 71 exchange lines and 20 private lines were in course of construction.

The Directors have to record with deep regret the death of their esteemed colleague, Mr. T. F. Campbell. The vacant seat on the Board has been filled by the election of Mr. Charles Billett. Mr. Alexander MacGregor retires from the Board by rotation, and, being eligible, offers himself for re-election. The shareholders' auditor, Mr. J. Weise, retires, and is eligible for re-election.

The following comparative statement of exchange and private line business is given in the report :—

	Exchange.	Private.
April 30, 1886	687	248
April 30, 1887	1,130	348
April 30, 1888	1,521	386
April 30, 1889	1,972	500

NEW COMPANIES REGISTERED.

THE ELECTRICITY SUPPLY COMPANY FOR SPAIN (LIMITED).—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares, of which 100 are founders' shares and 19,900 ordinary shares. Object: To form centres in any towns and districts in the Kingdom of Spain, at which electric power may be generated or accumulated, and from which the same may be distributed by means of wires or other conductors of electricity for the purpose of lighting private houses or street lighting, or the lighting of public buildings, shops, factories or works, or for the purpose of giving motive power or heating in all such places. There shall not be less than three nor more than seven directors. Qualification, £250 stock. Remuneration, £500 per annum, together with one-tenth of the net profits after 7 per cent. dividend, divisible as they determine.

THE ELECTRICITY SUPPLY CORPORATION (LIMITED).—Registered by Sydney Morse, 4, Fenchurch-avenue, E.C., with a capital of £100,000 in £10 shares (100 of which are founders' shares). Object: To apply for, obtain, undertake and carry out a Provisional Order for the supply of electric light and power within the parish of St. Martin's-in-the-Fields, in the county of Middlesex, and also generally any contracts, Acts, Provisional Orders, Licenses, decrees and concessions for, or in relation to, the supply of electricity in Great Britain or elsewhere ; to carry on the business of electrical engineers, electricians, engineers and contractors, manufacturers of electrical and other apparatus, &c. The first subscribers are :—

	Ordinary Shares.
J. Irving Courtenay, 1, Elm-court, Temple, E.C.	1
J. Barclay, 5, Clarendon-place, Hyde Park-gardens	1
Sir D. Cooper, M.P., 6, De Vere-gardens, S.W.	1
L. W. Novelli, Oxford and Cambridge Club, S.W.	1
J. Meston, 75, Union-street, Aberdeen	1
F. D. Finlay, 75, Gloucester-place, W.	1
F. King, 65, Chelverton-road, Putney	1

There shall not be less than five nor more than ten directors. Qualification, 50 shares. The first to be appointed by the subscribers to the Memorandum of Association. Remuneration to be determined in general meeting.

CITY NOTES, &c.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company notify that the coupons due 1st July next on their Five per Cent. Mortgage Debentures will be paid on and after that date by Messrs. Barclay, Bevan and Co., 54, Lombard-street, E.C. Coupons should be left at the bank three clear days for examination.

MESSRS. M'CULLOCH, SONS AND KENNEDY (LIMITED).—We announced on the 7th inst. that Mr. Rankin Kennedy had joined the firm of Messrs. M'Culloch and Sons, of Vulcan Works, Kilmarnock. A circular is issued by the firm announcing the completion of the arrangements for converting the firm into a limited liability concern under the old management. A circular from Mr. Kennedy states that he has transferred his patents and inventions in electrical engineering, together with his business formerly carried on at Woodside Electric Works, Glasgow, to the new firm.

METAL RECOVERY COMPANY.—The prospectus of this company has been issued this week, showing that the company is formed with a capital of £90,000 in £1 shares, principally to acquire the patent for Great Britain granted to Mr. J. E. T. Woods for improvements in the recovery of refuse metals ; also the right to take out patents in all foreign countries, British colonies and dependencies, and for the purpose of working and dealing with the same ; and also a patent provisional protection which has been granted to Mr. J. E. T. Woods for improvements in the manufacture of iron wire for telegraph and other purposes. The prospectus states that certain experimental works in connection with the recovery process have been put up, and some tons of tins have been successfully treated. The secretary of the company (*pro tem.*) is Mr. H. Cooper Mason, and the offices are at 72, Bishopsgate-street Within, London, E.C.

THE MINING AND GENERAL ELECTRIC LAMP COMPANY (LIMITED).—We are requested to state that on and after June 17th, the works address of the above company will be 64, Milbank-street, Westminster, to which place goods or communications should be sent.

WEST AFRICAN TELEGRAPH COMPANY.—The Directors recommend a dividend of 5s. per share in respect of the year ended 31st December, being at the rate of 2½ per cent. per annum. A year ago the distribution was 3s. per share.

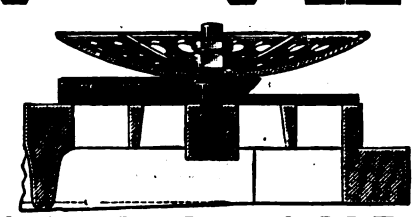
WEST COAST OF AMERICA TELEGRAPH COMPANY.—The coupons due the 30th inst. on this Company's debentures will be paid by Messrs. Barclay, Bevan and Co. The coupons must be left three clear days for examination.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this Company for the half-month ended June 15, 1889, were £3,157, as compared with £2,971 in the corresponding period last year, showing an increase of £186.

ENDOLITHIC IVORY.—At the Royal Military Tournament now being held at the Agricultural Hall, Islington, the badges used by H.R.H. the Prince of Wales, H.R.H. the Duke of Cambridge, the officers and gentlemen composing the various committees, and the judges, staff, and competitors, have been made by the Endolithic Ivory Company.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, June 19, 1889.		Rate per cent. Yielded.	Dividend Due.	Business done during Week ending June 19, 1889.	
						£ s. d.		Highest.	Lowest.
			TELEGRAPHS.						
£ 1,770,360	Stock	12/6	Anglo-American	52	53	3 15 6	Jan., Apr., July, Oct.	53½	52½
1,614,820	Stock	25/0	Do. Preferred	89	90	4 8 11	" "	90½	89½
1,614,820	Stock	...	Do. Deferred	18	18½	...	February	19	18½
130,000	£10	5/0	Brazilian Submarine	12⅝	13¼	5 6 8	Mar., June, Oct., Dec.	13 7/16	12⅝
112,900	£100	5%	Do. 5 per Cent. Bonds	102	104	4 16 2	January and July	104	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106	109	4 11 9	June and December.	107½	...
16,000	10	9/0	Cuba Submarine	14½	15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19	20	5 0 0	" "	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅞	4¼	4 4 8	March & September	...	...
6,000	5	5/0	Do. Preference 10%	8⅞	9⅛	5 5 3	April and October	...	...
60,710	20	3/6	Direct United States	10⅛	10⅜	4 13 8	Jan., Apr., July, Oct.	10⅜	10⅛
380,000	10	2/6	Eastern	13⅛	13⅜	4 9 9	" "	13⅜	13⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅜	15½	3 18 8	" "	15 1/16	14⅜
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108	110	3 12 9	May and November.	109½	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	4 10 11	February & August	108½	...
250,000	10	5/6	Eastern Extension	13⅜	13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	103	105	5 14 3	February & August	104½	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104	107	4 13 6	January and July	...	...
179,177	10	3/0	Globe Telegraph and Trust	8	8½	5 0 0	Jan., Apr., July, Oct.	8½	8
178,952	10	3/0	Do. 6 per Cent. Preference	14⅜	15	4 0 0	" "	14 11/16	14 1/16
150,000	10	5/0	Great Northern	15½	16¼	4 12 4	Jan., July, and April	16	15½
17,000	25	37/6	Indo-European	39	41	6 1 11	April and October	41	...
9,000	8	8/0	Reuter's	7	7½	5 6 8	April and October	...	...
15,609	10	3/0	West African Telegraph	9	10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101	104	4 16 2	March & September	102½	...
30,000	10	2/0	West Coast of America	10	10½	5 14 3	January and July	...	...
150,000	100	8%	Do. Debentures 8%	122	127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜	2⅝	...	...	2⅝	...
34,563	10	12/0*	Do. 1st Preference 6%	11⅞	12¼	...	April and October	12⅛	11⅞
4,669	10	...	Do. 6 per Cent. 2nd Preference	14	15	...	...	14⅝	...
45,181	15	9/0	Western Brazilian	11½	11⅝	6 3 7	March & September	12	11½
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114	118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100	102	5 17 8	March & September	...	...
			TELEPHONES.						
224,850	14/0	4½d.	Consolidated Telephone and Maintenance ... xd	⅜	⅞	...	Yearly	1 1/16	...
220,000	£1	3%	Oriental (11s. paid)	1/16	1/8	3 15 8	...	...	...
80,000	5	12/6	United xd	14½	15	5 16 8	June and December	15	14⅝
55,000	5	3/0	United River Plate	6¼	6½	...	January and July	6½	...
			ELECTRIC LIGHT.						
23,003	5	1/2	Anglo-American Brush (£4 paid)	3¾	4	...	...	3⅞	...
23,692	5	2/0	Do. (fully paid)	4⅛	4⅜	...	February & August	4⅜	...
79,934	5	...	Swan United (£3. 10s. paid)	3 1/16	3 1/8	...	...	3⅛	3½
			MISCELLANEOUS.						
37,350	12	36/0	Telegraph Construction and Maintenance	41	43	5 11 9	March and July	42½	41½
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19	20	5 0 0	February & August	...	...

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
J. G. Statter & Co., Limited.

PRINCE'S MANSIONS, VICTORIA STREET, WESTMINSTER.

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 580.—Vol. XXIII. FRIDAY, JUNE 28, 1889. Price Fourpence.

NOTES.

It will be seen by the verbatim report of Lord Trayner's judgment, which we publish in another column, that the Brush patent, No. 2,003, of 1878, has been invalidated. The claims contested, it will be remembered, were those for a peculiar form of commutator and a compound-wound machine. The claim for a commutator with "detachably attached sub-segments" has been held to be invalid, by reason of the claim in the final specification being "larger and different from that claimed in the provisional specification." Lord Trayner also holds that Brush's compound-wound machine was anticipated by Varley both by publication and use. The wide importance of this judgment can hardly be over-estimated, although, of course, the decision cannot be considered final until it has stood the test of appeal.

Whatever may be the legal value of Lord Trayner's arguments, there can scarcely be two opinions as to their lucidity and unusual brevity. There occurs towards the end of the judgment a paragraph which will probably act in certain cases as yet another incentive to obscure specifications, if indeed such be required. "A specification," the learned judge remarks, "may so insufficiently describe the process or the machine patented as to render the patent invalid. It may, nevertheless, contain sufficient description to disclose or publish the invention so as to prevent its being validly patented by another subsequently."

We furnish our readers this week with an analysis of the Model Provisional Order which has been issued by the Board of Trade, in which the chief points of departure from previous practice are indicated. We have taken as our chief standard of comparison the Chelsea Order of 1886, which remains the only Order yet confirmed by Act of Parliament; but we have also compared and collated the Model Order with some of the most important draft Orders which formed the subject of the recent inquiry. It will be seen that as compared with the Chelsea Act alone (to say nothing about the draft Orders) the alterations are uniformly against the interests of the Supply Companies. At the same time we do not find any really serious cause of complaint save in two most important points, upon which we have written at length in another part of this impression.

We are frequently asked about the duties of Electrical Inspectors by people who do not chance to be familiar with the terms of Provisional Orders or Licenses, and for this, and other reasons, we have taken the opportunity in the analysis referred to above to reprint the whole section relating to "Testing," as well as much of that relating to meters.

The meeting of the Electrical Section of the Chamber of Commerce was well attended as far as the General Committee was concerned, but the number of members present was disappointingly few. A resolution was passed, confirming the recommendation of the Committee that members should be deemed to have the right to attend every Committee meeting, and to speak on the invitation of the Chairman. An interesting report was read on the work of the Section, and copies were ordered to be furnished to the technical journals. Some discussion took place on the Model Order, when it appeared that those members who had made themselves acquainted with its contents felt the strongest objection to certain clauses. There was some talk of the Chamber appearing before Parliament in its corporate capacity to oppose the decision of the Board of Trade, but it appeared that those who are interested in Orders which they hope to get confirmed this session thought that, however objectionable these clauses might be, it would be impolitic to oppose them, and thus to risk the safety of the Bills.

It is easy enough to understand the feeling of anxiety to avoid everything which may tend to jeopardise the passage of the Bills, but on the other hand, it is certainly very unfortunate that the industry should have to submit to a Model Order which is open to such serious criticism simply because motives of policy prevent some of the leading men from joining to oppose it. As regards the County Council, we suppose we must make up our minds to submit unless the protest of the Paddington Vestry finds support—as we trust it may—in all the London vestries. But as regards the Inspector Clauses, we are happy to believe that they are so bad that they cannot possibly long survive the ordeal of actual enforcement.

Sir Arthur Blackwood's rejoinder to the United Telephone Company does not seem to carry the dispute much forwarder, or to help the public to a better understanding of its bearings. The necessity for some fuller and clearer statement than has yet been vouchsafed on the part of the Post Office is evidenced by the articles which appeared in last week's *Economist* and *Saturday Review*, both these high-class journals, though in

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opposite ways, misconceiving the issues, and misrepresenting the facts. The *Saturday Review* especially is singularly ill-informed on the whole subject; and when such leaders of public opinion as these go so far astray it is plain that a perfectly trustworthy account of the situation is very much needed. For one who "declines to be drawn into any further controversy," Mr. RAIKES, through the medium of the Secretary of the Post Office, is tolerably controversial on one point at least; but it happens not to be a very material point, the real question turning not upon whether amalgamation was intended or contemplated, but whether in the strict terms of their licenses the telephone companies can legally amalgamate.

As to the incidents upon which the United Company have, as we think, indiscreetly laid so much stress, the POSTMASTER-GENERAL seems to have decidedly the best of the argument. Even apart from historic facts it is pretty plain on the face of it that the Post Office never contemplated their amalgamation or the companies would not each have had a license covering the whole country. And, on the other hand, the parent company could hardly have been contemplating their amalgamation when it restricted its subsidiary companies to clearly-defined and separate areas—to say nothing of the large pecuniary interest it had in keeping them apart for the purpose of its own royalties. Mr. RAIKES still speaks of the amalgamation as only "projected," and it remains to be seen whether the companies will run the risk—real or apparent—of disregarding his warning. If they do, there is the contingent possibility of their business coming to an end next year; if they adopt the other course, dropping the project altogether, they will have a very substantial complaint against the Post Office, in which the public may sympathise, for hindering the natural development of telephonic industry.

IN common with many other electricians, we were much disappointed to find that the distinguished party of American Engineers, which has just left our shores, included so very few members of the electrical profession. We learn from our New York correspondent that it was at one time proposed by the American Institution of Electrical Engineers to organise with the other Societies for the purpose of a combined trip, but the idea fell through, owing chiefly to the fact that such a large proportion of the electrical engineers who were crossing the Atlantic were going on business which did not admit of any arrangement of this character. Amongst those who have already started are Messrs. T. D. LOCKWOOD, C. PRICE (of the New York *Electrical Review*), CARL HERING, LEWIS SEARING, J. M. SMITH, and PHELPS. Our correspondent adds that it is not unlikely that there will be a good muster at Newcastle for the British Association meeting.

ON the 28th March last, at the Institution of Electrical Engineers, Prof. AYRTON read at short notice a most valuable Paper by Prof. PERRY and himself under the title of "Laboratory Notes on Alternating-Current Circuits." Owing to the fact that the subject was not announced through the usual channels, and that the attendance was consequently somewhat meagre, this Paper has not hitherto received the attention which it deserves, and although it has since been published in the *Journal* of the Institution we have thought proper to reprint it in our columns. Next week, when the Paper will be completed, we hope to have something further to say upon the subject.

THE memorandum of precautions to be observed in the use of the electrostatic voltmeter, which has been drawn up by SIR WILLIAM THOMSON, and which will be found in another column, ought certainly to prevent a repetition of the recent sad accident at Messrs. SIEMENS' works. If the outer wooden case advocated in paragraph 3 had been employed, the inquisitiveness of the unfortunate man CONNELLY would not have been attended with fatal consequences.

WE print on another page the Bye-laws proposed by the Borough of Bradford in connection with the Corporation Supply of Electricity. Objections must be sent to the Board of Trade before 6th July. There is nothing calling for special remark in these regulations themselves, but they are of some interest as being the first example of the kind which has yet occurred.

Dundee.—We learn that the order for the lighting of the Albert Institute in this town has been placed with Messrs. Paterson and Cooper.

The Electric Sugar Swindle.—Howard, one of the Electric Sugar swindlers, has been sentenced to nine years and eight months' penal servitude.

Northampton.—At a special meeting held last week the Northampton Town Council gave their consent to the application for an electric lighting license by the Northampton Electric Light and Power Company.

Coventry.—The National Telephone Company opened an Exchange at Coventry on Monday last, and the town is now in telephonic communication with Birmingham, Sheffield, Nottingham, and the Black Country.

An Opening.—Ex-Consul Smith, of Carthagena, says that the Republic of Colombia presents a vast field for enterprise. Electric lights, waterworks, railways, and ice machines are particularly wanted just now, and the Government is "liberally disposed."

Nottingham.—The plans for the central station of the Nottingham Electric Light and Power Company will be submitted to the Corporation by the end of the month. The contract for the entire work has been undertaken by the Electric Construction Corporation.

The Halifax and Bermudas Cable Company.—In answer to a question by Dr. Cameron on Tuesday last, Mr. Jackson said the £15,000 deposit of this company had been received on the 7th of June, and had been invested in the name of the Paymaster-General.

Sale of Manufacturing Plant.—It will be seen by our advertisement columns that an important sale by auction of manufacturing plant and engineers' sundries will take place next week at Birmingham. Catalogues can be obtained of Messrs. Wheatley, Kirk, Price and Goulty.

Henley's Telegraph Works Company.—This company is about to ship 68 knots of submarine cable for the West Indies. They are also engaged in making a length of submarine cable for Denmark, and we hear that they will commence work almost immediately on the cable to connect Halifax (Nova Scotia) with Bermuda.

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Glasgow.—At a special meeting of the Glasgow Town Council on Monday last, it was decided to give notice of the intention of the Corporation to apply for a Provisional Order to supply electricity for public and private purposes. Messrs. Muir, Mavor and Coulson have also announced their intention to apply for a Provisional Order.

Edinburgh.—A Company called the Scottish Electric Supply Company has been established to undertake the work of electric lighting and the supply of electric power in Edinburgh and surrounding districts. A suitable site for the central station has been secured at Lochrin, adjoining the Union Canal, Edinburgh, where there is room for extension with every facility for the supply of coal.

The Electric Meter Competition in Paris.—The first meeting of the committee nominated by the town of Paris to judge the competing electric meters took place on June 12th. The competitors are 27 in number, although only 18 have sent actual apparatus; the rest have contented themselves with sending in drawings and photographs. It is said that a large proportion of the instruments possess considerable novelty.

The Franco-Chinese Telegraphic Contract.—According to Indian *Engineering* information has been received of the definite conclusion of the telegraphic contract between France and China on the Tonquin frontier. By this arrangement a wire will be laid down between Langson and Langchow, the capital of Kwangsi—80 kilometres from each other—and direct telegraphic communication will be then established between Saigon and Pekin.

Higgins' Single-Wire Column Printing Telegraph.—We have received from Mr. F. Higgins a sample of his new single-wire type-writer's performance. The printing is exceptionally clear, and being in column form instead of in slip is far more convenient to read. We learn that the Exchange Telegraph Company, who are the sole proprietors of the patents for these instruments, intend to take legal proceedings against all persons infringing their patents.

Bristol.—Mr. Preece has sent in a report of a very lengthy character to the Electrical Committee of the Bristol Town Council. It refers to what has been done in other towns in the matter of electric lighting and the results that have been obtained. Electricity cannot, he says, be supplied as cheaply as gas. As a motive power, he points out that electricity could be obtained cheaper in Bristol than in London and other places, on account of the difference in price of coal. Finally, Mr. Preece considers it advantageous for corporations to undertake their own lighting.

St. James's Vestry.—The St. James's Vestry passed the following resolution:—"That Messrs. Trinders and Co. be informed, in reply to their notice of the intention of the St. James's and Pall Mall Electric Light Company to apply for a Provisional Order, under the Electric Lighting Acts, in the next Session of Parliament, that the Vestry are not prepared to assent to the said company applying for a Provisional Order until they have acquired a generating station in the northern part of the parish, or are otherwise in a position to supply electricity throughout the whole parish."

Electric Traction on the North Metropolitan Tramway.—The first of the Electric Traction Company's cars, having been duly licensed by the police authorities and the Board of Trade, commenced running on the Barking-road section of the North Metropolitan Tramways Company on the 14th inst. A second car was put on the following day, and the six cars which will shortly entirely supersede horses will be placed in active work as soon as the drivers become accustomed to the new form of traction. These cars carry 52 passengers, and do 17 journeys daily with one change of accumulators.

Paddington Vestry.—The Vestry of Paddington, at a meeting last week, after considering the letter of the London County Council, addressed to the Board of Trade, on the subject of electric lighting, carried a resolution expressing the strongest exception to the proposals therein made for transferring the control and purchase of electric lighting in the metropolis from the Corporation, the vestries, and the district boards, to the County Council. The Vestry further resolved to forward a statement of its objections to the Board of Trade, the County Council, and the other representative governing bodies of the metropolis.

S.s. "Silvertown."—The India Rubber Gutta Percha and Telegraph Works Company has received a telegram from Mr. Matthew Hamilton Gray, engineer in charge, saying that the cable steamer "Silvertown" had successfully removed three faults from the cables connecting Dakar (Senegal) with Teneriffe without interrupting the working of the lines. As one of these faults was in the neighbourhood of Teneriffe and the other two near Senegal, some 800 nautical miles southward, and the work was carried out in about ten days, those engaged in the operations are to be congratulated on their success. The "Silvertown" is expected to arrive in London on 5th prox.

Personal.—A presentation took place at the offices of the Telephone Company of Ireland last week to Mr. Robert Morris, on his leaving the country for America. Mr. Morris has been with the Company from its inauguration to the present time, and is one of the best-known exponents of this branch of electrical science in Ireland. He was a general favourite with the public and the members of the staff, and his departure has caused universal regret. A very handsome non-magnetic silver watch and chain was subscribed for, and it was presented to him in the presence of the staff, who joined heartily in the general expression of goodwill and wishes for his future success.

The Proposed Electrical Engineering and Inventions Exhibition.—The first public meeting in connection with the Electrical Engineering and Inventions Exhibition, which it is proposed should be held in Edinburgh next year, took place on Thursday last week, Sir Thomas Clark, Bart., presiding. The Chairman moved—"That it be remitted to an interim executive committee, with power to add to their number, to carry out the Exhibition scheme, and to report progress to a future meeting of the general committee, to be held at such time as the interim executive committee consider advisable." After some little discussion, in which the necessity for a good site was strongly insisted upon, the motion was agreed to and the proceedings terminated.

Another Exhibition.—An Exhibition, to be called the Brighton and Hove International Exhibition of Arts, Sciences, Manufactures and Trades, is to be held at Hove in October next under the patronage of the leading local authorities of the neighbourhood. The exhibition building will be ready for exhibits on September 30th, and will remain open till Christmas. There will be a section devoted to electricity, and negotiations are in progress with the railway companies to obtain a special carriage rate for goods sent to the exhibition. Applications for space should be sent to the general manager at the offices, 14, Pavilion-buildings, Brighton, or 20, Bucklersbury, London. We wish Mr. Philip Shrapnel, the general manager, who is well known in connection with the various Exhibitions held in London, every success.

The Schoop Accumulator.—The chief object aimed at in the Schoop accumulator, which is manufactured at the well-known Oerlikon Works, is to attain durability, even when the cell is subjected to excessive charges and discharges. The grids, which are of triangular section, contain two-thirds the amount of litharge usually employed. It is said that with these plates there is no trouble from buckling or from the plugs falling out. The smallest-sized cells contain 11 plates, 2·5 millimetres thick and 14 centimetres square. The total weight of a complete cell is 7 kilogrammes, the plates weighing 4·5 kilogrammes. When discharged at the rate of 10 amperes and 35 amperes, their capacity is respectively 50 ampere-hours and 32 ampere-hours. The cells may be then discharged at any rate up to 70 amperes without sensibly diminishing the capacity.

Sherlock and Pattison's Engine-room Telegraph, and Mills Boat-Lowering Gear.—On Wednesday last a party of gentlemen, including Admiral Greville, Sir James Anderson, and others interested in the subject, left the Temple Pier for the docks in one of Messrs. Immisch's electric launches to inspect some boat-lowering gear and a new engine-room telegraph, fitted on board the Eastern Telegraph Company's cable ships, "Mirror" and "Electra." Mr. Mills' boat-lowering tackle showed itself very simple and effective. On board the "Electra" there was a

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very practical addition to the ordinary engine telegraph. On turning the handle to any order on the bridge dial, a simple attachment from the engine-room dial to the reversing gear causes a bell to ring both on the bridge and in the engine-room until the order has been properly obeyed. It is the joint invention of Mr. Sherlock, the head engineer, and Captain Pattison of the "Electra," and should be found very useful.

Brighton County Court.—At the Brighton County Court last week, the attention of the Judge was occupied for some time in hearing an action brought by James Foley Field, of Montague-street, Worthing, to recover £10 from the Brighton Electric Light Company as charges for allowing a pole and wires to remain on the premises No. 22, North-road, Brighton, where they had been erected as alleged without his permission. Defendant paid £1. 10s. into Court, without admitting liability. The evidence showed that a pole was fixed by arrangement with the landlord, and that it was simply replaced during the plaintiff's tenancy. His Honour held that a slight trespass had been committed by the defendant's men in going on the roof to change the old pole for a new one without permission of the plaintiff, but considered that sufficient had been paid into Court. A verdict was therefore given for the defendants.

A New Wire Process.—We learn that wire is now being manufactured—whether iron, copper, or brass—by a new and greatly-improved process, and at a considerably reduced cost. The machine devised for this purpose consists of a series of rolls in a continuous train, geared with a common driver, each pair of rolls having a greater speed than the pair preceding it, with an intervening friction clutch adapted to graduate the speed of the rolls to the speed of the wire in process of rolling. The entire operation of producing the smallest-sized wires from rods of one-half inch is done cold. It is alleged that this method obviates the danger of unequal annealing and of burning in the furnaces—in addition to this, the wire being more flexible and homogeneous than that made by any ordinary method, and capable of sustaining greater longitudinal strain; in the case of copper wire there is said to be a greatly increased electrical conductivity.

The Birmingham Electrical Exhibition.—The Executive Committee of the Electrical Exhibition in Bingley Hall are making arrangements for the introduction of several features of an interesting character. One novelty which has been decided upon is that of showing the practical workings of a coal mine. The mine will be lighted with electric lamps, and every visitor to the workings will be expected to carry a lamp so as to find his way about. Another feature will be the introduction of a telpher line, the order for which has been placed in the hands of the United Electrical Engineering Company, of Westminster. Mr. Vertegans has undertaken to construct an electrically-illuminated cascade and rockery, and an imposing electrical fountain will be arranged in the centre of the hall. The fountain will be an exact reproduction of the one in the court-yard of the Grand Hotel at Paris. This will be carried out under the superintendence of Messrs. Fowler and Lancaster, the electricians of the Exhibition.

Rare Metals.—The following list of the prices of rare metals, which we take from an American source, may be of service to some of our readers:—

	Per oz.		
Gallium	£650	0	0
Vanadium	64	0	0
Thorium	54	0	0
Glucinum	50	0	0
Zirconium	50	0	0
Lanthium	35	0	0
Cerium	32	0	0
Didymium	32	0	0
Lithium	32	0	0
Calcium	30	0	0
Yttrium	29	0	0
Erbium	28	0	0
Niobium	26	0	0
Strontium	26	0	0
Barium	16	0	0

	Per oz.		
Iridium	£11	0	0
Asmium	10	10	0
Rhodium	8	10	0
Palladium	6	10	0
Gold	4	0	0
Chromium	3	5	0
Indium	2	10	0
Platinum	2	0	0
Telurium	1	15	0
Potassium	0	10	0
Silver	0	4	0
Aluminium	0	3	0
Cobalt	0	2	0
Nickel	0	0	2½

Electric Welding of Pipes.—The *Engineering and Mining Journal* (New York) says:—"What was certain to follow the invention and development of electric welding of solid bodies by Prof. Elihu Thomson was that either he or some other worker in the same field of research would discover a method of making endless pipes by the adaptation of the discovery to that purpose. This has apparently been done by Mr. Elias E. Ries, of Baltimore, and patents have been granted covering the process. The main feature of the first patent is that the smooth interior of the pipe is secured by the use of a removable refractory core, made of some insulating material, while in the second case the same object is attained by subjecting the interior of the pipe while being welded to compressed air or fluid pressure. We expect to see this system largely adopted, especially in pipe lines and where the pipes are to be subjected to high pressure, as welded joints must, of their nature and from the tests made of welded bars, be stronger than any ordinary joint and proof against all leakage."

The Eiffel Tower Projectors.—In a recent issue of *La Nature* there appears a very striking illustration of the Eiffel Tower lit up on the opening night of the Exhibition, taken from what must have been a most successful photograph. It shows very clearly the diverse effects of the coloured fires, the lines of gas lamps, and the electric projectors on the summit of the tower. The latter resemble the arrangements of a first-class lighthouse, but the light is much more powerful. The arcs have a rated power of 5,500 carcels, which is concentrated by lenses and multiplied by reflection to six to eight million carcels in the direct ray, being the most intense luminous projection yet attempted. It is visible at the ground level to a distance of 67 kilometres; but by a spectator at an elevation sufficient to neutralise the curvature of the earth it should be seen at a distance of 203 kilometres. It has actually been detected from Bar-sur-Aube, which is 190 kilometres from Paris, by an observer placed on a hill 300 metres high. At these distances it appears as a simple luminous point.

A Movable Electric Light Station.—The Cumberland Valley Railroad Company, says *Invention*, has just completed at its shops at Chambersburg, Pa., a movable electric light station of wonderful illuminating power, and a novelty in railroading. It is intended to furnish light for wrecking purposes. The main car is 33ft. long by 9ft. wide, and 13½ft. high. The floor is of iron. In one end is a 40 horse-power vertical boiler and a 35 horse-power vertical automatic engine. The engine and boiler rest upon a cast-iron floor plate 9ft. by 11ft. In the other end of the car are two dynamos, one of 25 lights, the other of 15 lights, both of 2,000 candle-power. The dynamos are connected by belting with the engine. Under the car the lamps are carried, and also the tools for erecting the line. Attached to the car is a tender, to supply water and coal for the engine. Upon the tender are racks for carrying the poles, hoods for lamps, and a reel for holding the wire. The poles are made of hollow iron piping, of a handy and convenient pattern. The car will form a novel auxiliary to the equipment of the road, and it has attracted much attention from railroad men.

The late M. Gaston Planté.—A correspondent writes as follows:—"The news of the death of M. Gaston Planté has been received throughout the country with feelings of the deepest regret. It is strange that, although his genius and ability were universally recognised, so little is known of his very able book, entitled "The Storage of Electrical Energy," which contains a description of all his experiments with voltaic batteries, which finally led to the well-known form of Planté cell. Besides his experiments with all the common metals as voltaic couples, there are extremely interesting articles on the discharge of high-tension currents and globular lightning. It is doubtful if this latter subject has ever before been treated so completely, or with so many well-authenticated instances, which stand beyond dispute. The book cannot be too strongly recommended to all who have to do with secondary batteries, as it contains notes by the original inventor on the practical management of accumulators, and explains all the small but important difficulties which are so often met with, but which may be easily remedied and avoided by a little knowledge of their theory."

Barmen.—The following are some additional details respecting the central station at Barmen, an account of which appeared in *The Electrician* of May 17th. The plant comprises

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two Galloway boilers, working at 120lb. pressure, and two compound 100 horse-power engines running at 110 revolutions. Each engine drives two shunt machines, running at 500 revolutions, and having an output of 31 kilowatts, the present output of the station amounts to 104 kilowatts, the dynamos working 10 hours per diem and the storage-batteries doing the work the rest of the day. The distribution, as we mentioned in our previous account, is carried out on the three-wire system. Two sets of Tudor accumulators, arranged 68 in series and two in parallel, are connected across the mains, and by means of a switch which cuts out cells as required it is possible to keep the load on the dynamos always equal by sending the excess of current through the accumulators. The maximum rate of discharge of the cells is 220 amperes, and as the demand on the station at one time never exceeds 90 kilowatts, lasting six hours (3 p.m. to 9 p.m.), the accumulators can, if necessary, manage the load for eighteen hours out of the twenty-four. The Aron meter is used throughout, and the charge is 9d. per 1,000 watt-hours.

Barnet.—At the meeting of the Barnet Local Board, last week, the Lighting Committee submitted their report, recommending that the account of the electric lighting contractor, amounting to £95. 17s., for 71 lamps for three months, be paid. This recommendation, it was stated, had been arrived at after a long discussion. After some remarks, it was decided to pay the account. The Clerk read the draft of a letter in reply to one from Messrs. Ingledew, Ince and Co., dated the 14th ult., in which, it may be recollected by our readers, they complained of the resolution passed by the Board, declining to assist Mr. Joel in obtaining a Provisional Order, which would enable him to put the wires underground as required by the contract. The principal points in the draft were that Mr. Joel would not at present be called upon to lay the wires underground—the Board being disinclined to give him permission to break up the streets for this purpose; and they therefore released him from the obligation. At some future time, when affairs were more satisfactory, the Board might be induced to consider an application for a license extending over the term of the contract. It was agreed that the letter should be written, the Chairman remarking that he thought it expressed the feelings of the Board.

Fatal Accident at Siemens' Telegraph Works.—An inquest was held on Thursday last on the body of John Connelly, aged 31, a pensioner from the Royal Engineers, who was killed whilst at work at Siemens' Telegraph Works, Charlton, by an electric shock. Henry Percy Haynes, clerk in the electric-light department, said that at the dinner-hour on Tuesday he was in his office, when his attention was called to a man lying on the floor of the electric-light shop. He ran out and found Connelly lying on the floor with Sir William Thomson's electrostatic voltmeter in his hand. Alfred Dykes, electrical engineer, in the employ of Siemens Brothers, said that when he left at one o'clock he told deceased to keep the engine running steadily, and that if anything went wrong to stop the engine, and not attempt to touch any of the machines. Deceased had no business at or near the voltmeter; in fact, witness had several times warned him not to touch it. The pressure at the time was 1,000 volts. Edward Lankert, chief of the electric-light department, said that if one of the terminals of the instrument had been covered with a non-conducting material the accident would not have occurred. Dr. Hughes said that he was sent for and found deceased dead in the light shop. There were violet-coloured streaks up the right hand, with a perforation in the palm. In the left hand were three perforations. The heart and all the organs were healthy. The deceased had met his death from a shock of electricity.—The jury returned a verdict of "Accidental Death," and attributed no blame to the firm.

French v. English Electrical Engineers from a Yankee Point of View.—The Paris correspondent of the *New York Times* says:—"The jealousy of the French electricians, who are far behind the English in practical ability and knowledge, yet have fought bitterly against allowing any foreigners to share in the lighting contracts, has prevented anything like an intelligent use of the tower as yet for spectacular effects in illumination; but these will come in time, and no doubt they will be notable when they do come. The same spirit kept the question of elevators for the tower open until every other expedient had been tried, and recourse to an American firm was absolutely necessary. A whimsical story was told me the other day about the effort to shut the English firm out of the competition for working the coloured fountain display. Week after week the contracts which had been verbally promised the English company were delayed, after they had been fairly won, and at last it was announced that there would be another competition, conducted on slightly different lines, which necessitated rearranging the whole plant. While the English company were engaged in this, the manager noticed a suspicious number of young men with very commonplace clothes, but curiously white hands, loitering and sauntering about, but keeping a sharp watch in a furtive way on the English workmen. With great shrewdness he had the whispered word passed around to do everything wrong, regardless of expense or results, as long as the spies were about, and the men, entering into the spirit of the thing, elaborately mystified them. At night, when the new competition came on, the English had set everything right and gave a better display than ever, while the Frenchmen broke down with grotesque completeness at the outset. Thus it was that the English finally got their contract."

Leeds.—The Electric Lighting Committee of the Corporation of Leeds issued last Friday to the members of the Town Council a report, consisting of 27 pages, in which are reviewed the proceedings of the committee since its formation, and the particulars of a scheme for lighting the town from a central station. It appears that the committee have expended £10,233. 18s. 11d. on capital account, which is the sum the Council granted for experiments. The report goes on to say that whilst the Council's instruction to the committee were limited to making experiments in and about the Town Hall, in compliance with a generally-expressed wish it has deemed it its duty to go into the question of lighting with electricity the centre of the town. To secure the best possible method the committee has visited various towns where the electric light is used, and then sought information from the tenants of shops bounded by Albion-street, Boar-lane, Briggate, and Commercial-street, to ascertain the disposition of the tradespeople in regard to an electric light supply. The desire to have the electric light was almost unanimous. The committee then mapped out the district bounded by Vicar-lane, New Market-street, Duncan-street, Briggate down to the Bridge, Boar-lane to the New Station, Park-row, Guildford-street, Upperhead-row, New Briggate, and North-street to Vicar-lane, and, after ascertaining the exact number of lamps which would be required in a given area, and using this as a basis, it was found that the number of public and private lamps required for lighting this district would be about 37,500. The piece of land known as "the Midden" has been fixed upon for the central station, and tenders show that the machinery and other plant required will cost in all about £58,000. To supply private residences, however, would cost an additional £10,000, making in all £68,000. As to the question of cost, the committee is of opinion that an incandescent 10 candle-power lamp can, after paying for depreciation and interest, but not making a profit, be run for one-eighth of a penny per lamp per hour. Comparing this with the present price of gas in Leeds, electric lighting can be supplied at 20 per cent. above that price; but as the customers would have in addition to pay for renewing their lamps this would probably add 40 per cent. to the total cost, according to the present price, or taking gas and meters at 2s. per 1,000 feet, the electric light would in price be equal to gas at 3s. 5d. per 1,000 feet. The report then recommends that portions of the Town Hall and Municipal Buildings be lighted by electricity at a cost of £3,000; that the Council apply to the Board of Trade for a Provisional Order authorising the Corporation to provide and supply electricity for public and private lighting purposes within the area referred to in the report, at an estimated total capital expenditure of £68,000; that the Council authorise the Electric Lighting Committee to carry out and complete an initial installation of electric lighting within the district mentioned in the report, at an estimated capital expenditure of £25,000, such sum being part of the sum of £68,000 to be borrowed under the authority of the Provisional Order.

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PRECAUTIONS FOR SAFETY IN THE USE OF SIR W. THOMSON'S ELECTROSTATIC VOLTMETERS.

BY SIR W. THOMSON.

[We have been furnished with a copy of the following memorandum of precautions to be observed in using Sir William Thomson's electrostatic voltmeters in connection with alternating or continuous current dynamos, and which will be issued with all instruments supplied.]

§ 1. In all applications in which one of the two conductors connected with the voltmeter is kept permanently connected with the earth, this conductor should be connected with the outer case of the voltmeter. The other conductor is to be connected with the insulated terminal, and must be carefully guarded against accidental contacts.

§ 2. To provide for use in any application not fulfilling the condition of § 1, all the electrostatic voltmeters are supplied with thoroughly insulating feet; and the precautions stated below in § 3 and § 4 must be observed.

§ 3. The vertical-scale voltmeter for from 400 to 12,000 volts, when set up for permanent use, should be enclosed in a case (which may be of wood with a glass front) preventing any person from accidentally touching the metal case or the terminals of the instrument. The vibration-checker is worked with perfect safety by a silk cord passing through a hole in the wood or glass of the protecting case to the front outside. For temporary or experimental applications the user must take his own precautions; an outer enclosing glass case might be found too cumbrous.

§ 4. For ordinary domestic electric lighting or other applications to less than 200 volts, the multicellular voltmeter may be left unprotected so far as personal danger is concerned; but, to avoid chances of damage to instruments or wires, or of melting a fuse, its outer case, as well as its terminal insulated from the outer case, ought to be perfectly guarded against accidental contacts when the instrument is set up for permanent use. Glass and vulcanite sheaths are provided for this purpose by the instrument-maker when desired.

§ 5. *General Warning.*—Never open the case of the vertical-scale voltmeter to change its weights, nor touch its terminals to connect or disconnect (or to secure either connection if imperfectly made), without being sure either that the dynamo is not running or that both the conductors leading to the voltmeter are safely disconnected from its circuit.

§ 6. It may be asked, with reference to the vertical-scale voltmeter, why is the inner case made of metal? The answer is, that the electric conditions for definiteness of measurement require the vane to be protected all round from sensibly disturbing influence of any substance, other than the air around it, differing in potential from itself unless at the same potential as the quadrants. Why, then, not coat the metal inner-case with wood or vulcanite, or other non-conducting material? Answer: The protection thus imagined might be delusive when 10,000 volts is dealt with. Safety is most surely secured by an outer case an inch or so from the inner metal, unless, *which is always best when it can be arranged for*, one of the conductors is kept connected with the earth, and with the metal case of the electrometer also connected with the earth.

THE MODEL ORDER (METROPOLITAN AREA).

The chief points of difference between the clauses of the Model Provisional Order (Metropolitan District) which has just been issued, and the stipulations most commonly found in earlier Orders, are summarised below. We also print at full length the entire section relating to "Testing" and part of that relating to "Meters," much of which will be of interest at the present time to a wide circle of readers.

The term "energy," which is defined to mean electrical energy, is used throughout instead of "electricity" or "electric current."

A clause is inserted forbidding the Undertakers to acquire the business of any other Supply Company without the consent of the Board of Trade under penalty of revocation of Order.

Nature and Mode of Supply.

The following additional clause appears under this head:—

Systems and mode of supply. 9. . . . . (2.) The Undertakers shall not permit any part of any circuit to be connected with earth except so far as may be necessary for carrying out the provisions of any such regulations or conditions as aforesaid, unless such connection is for the time being approved of by the Board of Trade with the concurrence of the Postmaster-General, and is made in accordance with the conditions, if any, of such approval; and

(3.) The Undertakers shall so construct their mains and other works of all descriptions, and shall so work their undertaking in all respects, as not injuriously to affect by induction or otherwise other electric circuits from time to time used or intended to be used for the purpose of telegraphic, telephonic, or electric signalling communication, or the currents in such circuits; but as regards electric circuits erected or laid down for the purposes aforesaid after the construction of such mains or works, the provisions of this subsection shall only apply if reasonable and proper precautions have been taken in the erection or laying down of such last-mentioned electric circuits, and if they have not been erected or laid down in unreasonably close proximity to such mains or works. If any question arises as to whether the undertakers have constructed their mains or other works, or work their Undertaking, in contravention of this subsection, such question shall be determined by arbitration.

Works.

The following additional clause appears under this head:—

Prohibition of Overhead Wires. 11. . . . . The Undertakers shall not, without the express consent of the County Council, place any electric line above ground, along, over, or across any street.

If the Undertakers place any electric lines in contravention of this section they shall be liable to a penalty not exceeding ten pounds for every such offence, and in the case of a continuing offence to a further penalty not exceeding five pounds for every day after the first day during which such offence continues.

Where any electric lines of the Undertakers have been placed above-ground as aforesaid before the commencement of this Order they shall be removed by the Undertakers within a period of two years after such commencement, and if not so removed may be removed by the local authority or by the County Council (if the street is repairable by them), and sold by public auction or private contract for such sums and to such persons as the local authority or County Council may think fit; and the local authority or County Council may out of the proceeds of such sale reimburse themselves the amount of the costs of the removal and sale, and the balance of the proceeds of sale (if any) shall be paid over by them to the Undertakers. . . .

The whole of the clauses relating to the serving of notices and maps upon the local authority and the Postmaster-General, the breaking up of streets, alterations to pipes, wires, &c., under streets, and interferences with the service of the Telephone Companies, remain practically unaltered. The following new clause is added at the end of the section:—

Provision as to subways. [31 and 32 Vict. c. lxxx.] 18. If any subway has been constructed within the area of supply, whether before or after the commencement of this Order, to which the Metropolitan Subways Act, 1868, applies, that Act shall apply to any electric line of the Undertakers as if electric line had been included in the term "pipe" as defined by that Act, and as if this Order were a special Act of Parliament.

Compulsory Works.

Clauses 19 and 20 have been remodelled as follows:—

Mains, &c., to be laid down in streets specified in Second Schedule. 19. The Undertakers shall, within a period of two years after the commencement of this Order, lay down suitable and sufficient distributing mains for the purposes of general supply throughout every street or part of a street specified in that behalf in the Second Schedule, and shall thereafter maintain the same.

Mains to be laid down in remainder of area of supply. 20. In addition to the mains specified in the last preceding section the Undertakers shall, *at any time after* the expiration of eighteen months after the commencement of this Order, lay down suitable and sufficient distributing mains for the purposes of general supply throughout every other street or part of a street within the area of supply, upon being required to do so in manner by this Order provided.

[It would appear from this that the Undertakers are not at liberty to supply energy beyond the scheduled district of the area until after the lapse of 18 months. Six months is allowed for the carrying out of the work after notice of requisition.]

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The clauses relating to requisitions to supply current have been remodelled, but the only practical difference is to allow the Undertakers, *if they please*, to accept a guaranteed rental amounting to *less* than 20 per cent. of the cost of the extension.

TESTING.

We now come to the Section on Testing, which we reprint in full. In the first paragraph (Clause 28), the words "County Council" replace "Local Authority." Other changes which are not numerous are indicated in square brackets.

Appointment of electric inspectors by County Council. 28. The County Council, so long as they are not themselves the Undertakers for the purposes of this Order, shall from time to time appoint, and keep appointed, one or more competent and impartial persons to be electric inspectors for the purpose of inspecting electric lines and works and of certifying meters under this Order.

Appointment of electric inspectors by Board of Trade in certain cases. 29. If no electric inspector is appointed by the County Council [in earlier Orders and in the Chelsea Act the following words are interpolated here:—"*or if the inspection of mains or works is imperfectly attended to by the local authority*"] or if the County Council themselves become the Undertakers for the purposes of this Order, the Board of Trade, on the application of any person supplied with energy by the Undertakers within the area of supply, or of the Undertakers, may from time to time appoint, and keep appointed, one or more competent and impartial person or persons to be electric inspectors for the purposes aforesaid.

Remuneration of Electric Inspectors. 30. The County Council shall pay to every electric inspector appointed under this Order such reasonable remuneration (if any) as they, or (in case of an electric inspector appointed by the Board of Trade) the Board of Trade may from time to time determine, and such remuneration may be in addition to, or in substitution for, any fees which are directed to be paid to electric inspectors for services rendered by them under this Order, as may be settled by the authority by whom such remuneration is determined. Provided that where any such remuneration is settled to be in substitution for such fees as aforesaid, such fees shall, in lieu of being paid to such electric inspector for his own use, be due and paid to him on behalf and for the use of the County Council, and shall be carried by them to the county fund.

Testing of Mains. 31. Every electric inspector, if and when required to do so by the authority by whom he is appointed, shall from time to time test for insulation and conductivity any portion of any main of the Undertakers within the area of supply through which energy is, or is intended to be, supplied by them; provided that such testings shall not be made in regard to any particular portion of a main oftener than once in any three months, unless in pursuance of a special order in that behalf made by the Board of Trade.

Testing of Service Lines. 32. Every electric inspector, if and when required to do so by any person supplied with energy by the Undertakers, shall from time to time test for insulation and conductivity any service lines by which such energy is supplied and the efficiency of any joints in such service lines, and make such other tests in relation to such service lines as may from time to time be approved of by the Board of Trade.

Mode of testing. 33. Notice shall be given to the Undertakers before the commencement of any testing by an electric inspector, and such testing shall be carried out at such suitable hours as, in the opinion of such inspector, will least interfere with the supply of energy by the Undertakers and in such manner as such inspector may think expedient, but except under the provisions of a special order in that behalf made by the Board of Trade, he shall not be entitled to have access to or interfere with the mains of the Undertakers at any points other than those at which the Undertakers have reserved for themselves access to the said mains: Provided that the Undertakers shall not be held responsible for any interruption in the supply of energy which may be occasioned by or required by such inspector for the purpose of any such testing as aforesaid.

Report of results of testing. 34. Every electric inspector shall, on the day immediately following that on which any testing has been completed by him under this Order, make and deliver a report of the results of his testing to the authority or person by whom he was required to make such testing, and to the Undertakers, and such report shall be receivable in evidence.

[*New par.*]—If the Undertakers or any authority, company, or person are or is dissatisfied with any report of any electric inspector they may appeal to the Board of Trade against such report, and thereupon the Board of Trade shall inquire into and decide upon the matter of any such appeal, and their decision shall be final and binding on all parties.

Undertakers to establish testing stations. 35. The Undertakers shall at such places, within a reasonable distance from any distributing main, establish at their own cost such reasonable number of testing stations as the County Council [previously the Board of Trade] shall deem sufficient for testing the supply of energy by the Undertakers through such main, and shall place thereat proper and suitable instruments of a pattern to be approved by the Board of Trade, and shall connect such stations by means of proper and sufficient electric lines with such mains, and supply energy thereto for the purpose of such testing.

If any dispute arises between the County Council and the Undertakers as to whether the number of such testing stations and the distance from the main at which they are established is reasonable or excessive, or as to any excessive or improper use of energy for such testing, or as to the performance by the Undertakers of their duties under this section, such dispute shall be determined by arbitration.

Undertakers to keep instruments on their premises. 36. The Undertakers shall set up and keep upon all premises from which they supply energy by any distributing mains such suitable and proper instruments of such pattern and construction as may be from time to time approved of or prescribed by the Board of Trade, and shall from time to time take and record, and keep recorded, such observations as the Board of Trade may from time to time prescribe, and any observations so recorded shall be receivable in evidence.

Readings of instruments to be taken. 37. The Undertakers shall keep in efficient working order all instruments which they are required by or under this Order to place, set up, or keep at any testing station or on their own premises, and any electric inspector appointed under this Order may from time to time examine and record the readings of such instruments at such times and in such manner as he may be directed by the authority by whom he is appointed, and any reading s so recorded shall be receivable in evidence.

Electric inspector may test undertakers' instruments. 38. Any electric inspector appointed under this Order shall have the right to have access at all reasonable hours to the testing places and premises of the Undertakers for the purpose of testing the electric lines and instruments of the Undertakers, and ascertaining if the same are in order, and in case the same are not in order he may require the Undertakers forthwith to have the same put in order.

Representation of Undertakers at testings. 39. The Undertakers may, if they think fit, on each occasion of the testing of any main or service line, or the testing or inspection of any instruments of the Undertakers by any electric inspector, be represented by some officer or other agent, but such officer or agent shall not interfere with the testing or inspection [in most of the Orders this clause concludes with the following words:—Unless such officer or agent shall have reasonable ground for apprehending that the mode of test or inspection adopted will injure the main, instruments, or other apparatus, or interfere with the supply of electricity to the public.]

Expenses of testing. 40. All expenses of testing by an electric inspector, including such reasonable fees to the electric inspector as may from time to time be prescribed in that behalf by the local authority, with the approval of the Board of Trade, shall be paid by the Undertakers, unless the report of the electric inspector, or, in the case of an appeal, the decision of the Board of Trade, shows that the local authority or any body or person supplied with energy was guilty of any default or negligence; and in such case the expenses of the testing, including such fees as aforesaid, shall be ascertained by a court of summary jurisdiction and paid by such local authority, body, or person as the court shall direct. [Previously the Undertakers paid only in cases where default was proved.]

Undertakers to give facilities for testing. 41. The Undertakers shall afford all facilities for the proper execution of this Order with respect to testing and the readings and inspection of instruments, and shall comply with all the requirements of or under this Order in that behalf; and in case the Undetrakers make default in complying with any of the provisions of this section they shall be liable to a penalty not exceeding five pounds, and in the case of a continuing offence to a further penalty not exceeding one pound for every day after the first day during which such offence continues.

Remedying of defects in mains, &c. [*New Clause.*]—42. If at any time it appears to the Board of Trade that any mains, electric lines, or works of the Undertakers are defective and not in accordance with the regulations and conditions subject to which the Undertakers are for the time being authorised to supply energy under this License, the Board of Trade may, by order in writing, require the Undertakers to remedy such defect so as to comply with such regulations and conditions within such period as may be therein limited in that behalf, and if the Undertakers make default in remedying such defect within the time so limited they shall be liable to a penalty not exceeding twenty pounds for every day during which such default continues. Provided that if such defect is, in the opinion of the Board of Trade, dangerous to public safety, they may also by any such Order as aforesaid forbid the use of such main, electric line, or work as from such date as may be specified in that behalf until the defect is remedied, and if the Undertakers make use of any such main, electric line, or work while the use thereof is so forbidden they shall be liable to a penalty not exceeding one hundred pounds for every day during which such user continues.

The two following clauses, which appeared in the Chelsea Act and in most of the recent draft Orders, are now omitted:—

Mode of testing. Notice shall be given to the Undertakers before the commencement of any testing by an electric inspector, and such testing shall be carried out at such suitable hours as, in the opinion of such inspector, will least interfere with the supply of electricity by the Undertakers, and in such manner as such inspector may think expedient, but except under the provisions of a special Order in that behalf made by the Board of Trade, he shall not be entitled to have access to or interfere with the mains of the Undertakers at any points other than those at which the Undertakers have reserved for themselves access to the said mains: Provided that the Undertakers shall not be held responsible for any interruption in the supply of electricity which may be occasioned by

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or required by such inspector for the purpose of any such testing as aforesaid.

Undertakers may test instruments of local authority. The Undertakers shall have the right to have access at all reasonable times to such instruments for the sake of testing the same and ascertaining if the same are in order, and may require the local authority forthwith to have the same put in order in case they are not so.

SUPPLY.

The distance up to which the Undertaker is bound to extend service wires, free of charge is increased from 30 to 60 feet.

The clause relating to inspection of an occupier's fittings by the Undertakers' agents has been cut down to the following dimensions :—

. . . . Provided also that the Undertakers shall not be compelled to give a supply of energy to any premises unless they are reasonably satisfied that the electric lines, fittings, and works therein are in good order and condition, and not calculated to affect injuriously the use of energy by the Undertakers or by other persons.

PRICE.

The second paragraph of the following clause is new :—

Maximum prices. 48. The prices to be charged by the Undertakers for energy supplied by them shall not exceed those stated in the Fourth Schedule.

Provided that if the County Council, the local authority, or the Undertakers, shall, at any time after the expiration of seven years after the commencement of this Order, make a representation to the Board of Trade that the prices or methods of charge stated in the said schedule ought to be altered, the Board of Trade, after such inquiry as they may think fit, may make an Order varying the prices or methods of charge stated in the said schedule or substituting other prices or methods of charge in lieu thereof, and the prices or methods of charge so varied or substituted shall have effect on and after such day as may be mentioned in the Order, as if they had been stated in the said schedule. Provided also, that the prices and methods of charge for the time being in force may be altered in like manner at any time after the expiration of any or every period of seven years after the same were last altered.

The schedule provides that—

Where the Undertakers charge any consumer by the actual quantity of energy supplied to him, they shall be entitled to charge him at the following rates per quarter :—For any quantity up to twenty units, thirteen shillings and fourpence ; and for each unit over twenty units, eightpence.

METERS.

The following are the principal clauses relating to meters; they have not undergone much alteration :—

Meters to be used except by agreement. 51. The energy supplied by the Undertakers to any ordinary consumer under this Order, or the electrical quantity contained in such supply (according to the method by which the Undertakers elect to charge), in this Order referred to as "the value of the supply," shall, except as otherwise agreed between such consumer and the Undertakers, be ascertained by means of an appropriate meter duly certified under the provisions of this Order.

Meter to be certified. 52. A meter shall be considered to be duly certified under the provisions of this Order if it be certified by an electric inspector appointed under this Order to be of some construction and pattern, and to have been fixed and to have been connected with the service lines in some manner approved of by the Board of Trade, and to be a correct meter ; and every such meter is in this Order referred to as a "certified meter"; provided that where any alteration is made in any certified meter, or where any such meter is unfixed or disconnected from the service lines, such meter shall cease to be a certified meter unless and until it be again certified as a certified meter under the provisions of this Order

Fees for certifying meters. 53. Every electric inspector who may be required by the Undertakers or by any consumer to examine any meter for the purpose of certifying the same as a certified meter under the provisions of this Order shall be entitled to demand from the Undertakers or consumer so requiring him and to be paid such fees as may from time to time be determined in that behalf by the County Council with the approval of the Board of Trade, before commencing such examination, and every electric inspector shall, upon being required so to do by the Undertakers or any such consumer as aforesaid, examine any meter situate within the district for which he is appointed if such fees are offered to him as aforesaid, and shall certify the same as a certified meter if he considers it entitled to be so certified.

Undertakers to supply meters if required to do so. 54. Where the value of the supply is under this Order required to be ascertained by means of an appropriate meter, the Undertakers shall, if required so to do by the consumer, supply him with an appropriate meter . . . . and procure such meter to be duly certified . . . .

Meters not to be connected or disconnected without notice. 55. No consumer shall connect any meter used or to be used under this Order for ascertaining the value of the supply with any electric line through which energy is supplied by the Undertakers, or disconnect any such meter from any such electric line, unless he has given to the Undertakers not less than forty-eight hours' notice in writing of his intention so to do, and if any person acts in contravention of this section he shall be liable for each offence to a penalty not exceeding forty shillings.

Consumer to keep his meter in proper order. 56. Every consumer of energy supplied by the Undertakers shall at all times at his own expense keep all meters belonging to him, whereby the value of the supply is under this Order to be ascertained, in proper order for correctly registering such value, and in default of his so doing the Undertakers may cease to supply energy through such meter.

The Undertakers shall have access to and be at liberty to take off, remove, test, inspect, and replace any such meter at all reasonable times, provided that all reasonable expenses of and incident to any such taking off, removing, testing, inspecting, and replacing, and the procuring such meter to be again duly certified where such re-certifying is thereby rendered necessary, shall, if the meter be found to be not in proper order, be paid by the consumer, but if the same be in proper order all expenses connected therewith shall be paid by the Undertakers. . . .

Undertakers to keep meter let for hire in repair. 58. The Undertakers shall, unless the agreement of hire otherwise provides, at all times, at their own expense, keep all meters let for hire by them to any consumer, whereby the value of the supply is ascertained, in proper order for correctly registering such value, and in default of their so doing the consumer shall not be liable to pay rent for the same during such time as such default continues. The Undertakers shall, for the purposes aforesaid, have access to and be at liberty to remove, test, inspect, and replace any such meter at all reasonable times : Provided that the expenses of procuring any such meter to be again duly certified where such re-certifying is thereby rendered necessary shall be paid by the Undertakers.

Differences as to correctness of meter to be settled by Inspector. 59. If any difference arises between any consumer and the Undertakers as to whether any meter whereby the value of the supply is ascertained (whether belonging to such consumer or the Undertakers), is or is not in proper order for correctly registering such value, or as to whether such value has been correctly registered in any case by any meter, such difference shall be determined upon the application of either party by an electric inspector, or, where the County Council are the consumers, by an inspector to be appointed by the Board of Trade, who shall also order by which of the parties the costs of the proceedings before him shall be paid, and the decision of such inspector shall be final and binding on all parties. Subject as aforesaid, the register of the meter shall be conclusive evidence in the absence of fraud of the value of the supply.

LABORATORY NOTES ON ALTERNATING-CURRENT CIRCUITS.*

BY PROFS. W. E. AYRTON, F.R.S., AND JOHN PERRY, F.R.S.

At the last meeting, Prof. Perry and I received an urgent request from your indefatigable secretary to read a Paper at this meeting, as unforeseen circumstances had prevented the authors of two other Papers from sending them in in time. We pointed out that we had no Paper ready ; we were, however, urged to do something, and it occurred to us that possibly some short account of a few of the experiments that some of the students of the Central Institution are at present engaged upon might be of interest to the members.

You are of course all aware that, when you are dealing with varying currents, self-induction is of importance ; indeed, if the alternations are only sufficiently rapid, self-induction completely replaces resistance, the resistance becomes entirely unimportant, and self-induction is all-important. In the case, for instance, of a well-made transformer, the resistance of the primary circuit may be practically neglected altogether, and all that you have to consider in order to determine what current will flow through the primary circuit for a given mean potential difference at the terminals is the effective coefficient of self-induction. In spite of the importance that self-induction possesses, and in spite of the fact that the largest distributions of electric power in this and in other countries are carried out by means of alternating currents, there is a wonderful amount of ignorance possessed by us all as to what is the coefficient of self-induction of any particular circuit. We have, in fact, no instinctive feeling whatever as to the value of the self-induction of a coil or a circuit when we see it. Some time ago we were asked by a well-known physicist whether we could tell him what was the self-induction of a Thompson reflecting galvanometer of the ordinary form, having about 7,000 ohms resistance. He said, "I am not particular to 50 per cent., or even 100 per cent., but can you give me any sort of idea as to what it is? Is it, for example, to be measured in centimetres or in miles? and is it a large number of miles or a small number of centimetres?" Well, that impressed upon us how little was any instinctive feeling as to

* Extract from the *Journal* of the Institution of Electrical Engineers Part 79, Vol. XVIII.

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the magnitude of the coefficient of self-induction of any particular coil called into existence by the appearance of the coil.

As an example, here is a coil wound so that you can see the number of layers, as well as the number of convolutions in each layer. The wire is thick, so that the total number of convolutions can be easily counted, and is seen to be 600. Now, although there is no iron in this core, and although the windings are practically symmetrical, we think that probably no single person in this room can say what is even the approximate value of its self-induction. Were we to tell you that the resistance of this coil were a megohm or a microhm, you would smile, because your experience tells you that the resistance must be of the order of a few ohms. As a matter of fact it is 1·34 ohm. Possibly you could not say from merely looking at the coil whether its resistance was half an ohm or 5 ohms, but if there be no discontinuity nor short circuit you are perfectly certain that a megohm is far above the true value and a microhm far below. But if we were to tell you that its self-induction was a million miles, not a single brow would be raised in astonishment; or if we were to state that it was about 20 yards, you would receive that statement with perfect equanimity; or even if we were to say that it is about 100 miles you would not smile—well, you ought not to smile in that case, for it is about 100 miles, being in reality 92 miles.

Now, how have we got this clear notion with reference to resistance? Obviously by a large number of measurements having been made, by having had to find out what was the resistance of all sorts of lengths of wires and of coils of various sizes and shapes, and therefore we know, from a sort of instinct which has grown up as the result of a large number of measurements, what is roughly the resistance of any particular wire when we see it. It therefore seemed to us that it might be of some interest to you to have the results that have been obtained by various students as to what are the actual coefficients of self-induction of some simple circuits.

The experiments have been made by various groups of students under the charge of Mr. Sumpner; in fact, for some time past, scarcely a coil has been allowed to remain peaceably at rest in our laboratory, but it has been operated on, and its coefficient of self-induction measured. Hence our students are just beginning to acquire that instinctive feeling of which we have spoken, regarding the magnitude of the self-induction of different circuits, and it is our desire to go a little way this evening towards imparting that feeling to you.

First, of course, we must be familiar with the practical unit of self-induction. We should like to be able to say that of course you are all familiar with it, but in view of recent experience we fear that that would be too great an assumption; for only quite recently, at a meeting of the Institution of Civil Engineers, a very large mistake was made by a well-known electrical engineer regarding the magnitude of the unit of self-induction—a mistake which, we pointed out at the time, was very like that of confusing the distance between here and Charing-cross, which is about a mile, with the distance from here to the sun, which is about 100,000,000 miles. The practical unit of self-induction is $99{,}777 \times 10^4$ centimetres; it is not exactly the earth's quadrant, in consequence of the legal ohm not being exactly the intended or true ohm, and therefore, if you want the equation

$$r\,C + L\frac{d\,C}{dt} = E$$

to be true, where r is in ohms, C in amperes, and E in volts, L must be expressed in a unit which is $99{,}777 \times 10^4$ centimetres, about 6,200 miles.

For want of a better name, we suggested some few years ago that the name "secohm" should be employed for this unit, it being of course a second × an ohm, so that a secohm is really $99{,}777 \times 10^4$ centimetres, or about 6,200 miles, or two-hundredths of a secohm is rather more than 300 miles.

When making that suggestion, we showed you an arrangement, which we called a secohmmeter, for enabling the coefficients of self-induction to be measured with the same facility that you have been accustomed to measure an ordinary resistance with a Wheatstone's bridge. Of course, self-induction only shows its effect when currents are varied. You cannot, of course, measure it by steady currents; but by performing certain operations which were explained to you some two years ago you are able to make the measurements with alternating currents or varying currents nearly as easily as you are accustomed to measure resistances by the use of steady currents.

In the secohmmeter that we devised the operation that was performed was this: The battery circuit was alternately made and broken, and during one of these operations—say, during the make of the battery circuit—the galvanometer was rendered inoperative by being short-circuited, so that during every break of that battery circuit the battery was operative, while during every make the galvanometer ceased to be operative. In that way the effect of self-induction was apparently to increase the resistance of a particular circuit by a definite amount, depending on the speed, and from the apparent increase of resistance and the speed the coefficient of self-induction was determined. Since then we have made various alterations in the instrument. One improvement was a very obvious one—to reverse the battery instead of making and breaking the battery circuit, and lastly, to reverse the galvanometer instead of short-circuiting it; so that, at present, with the latest form of the secohmmeter we alternately reverse the battery circuit and the galvanometer circuit, and, as four reversals of each circuit occur for each rotation of the commutator spindle, the sensibility of the latest form is eight times as great as the first form that we had the honour of bringing before the Society two years ago.

The commutators can be driven at one or other of two speeds relatively to that of the driving handle. With one arrangement there are rather more than eight reversals of both the galvanometer and of the battery for one revolution of the handle, and with the other twenty-four reversals of each for one revolution o the handle. The apparatus is so constructed that the speed of the fly-wheel remains the same relatively to that of the handle, whatever speed ratio be employed, and hence the same uniformity of speed can be obtained with either speed ratio. The secohmmeter can be conveniently driven by hand so as to obtain a constant speed of reversal varying from 300 to 6,000 reversals per minute of both the galvanometer and the battery.

To shift from one speed ratio to the other, press down the end of the locking lever at the right of the secohmmeter, and slightly push in or pull out the handle, turning it slightly to assist the toothed wheels engaging properly; when engaged, let go the end of the locking lever.

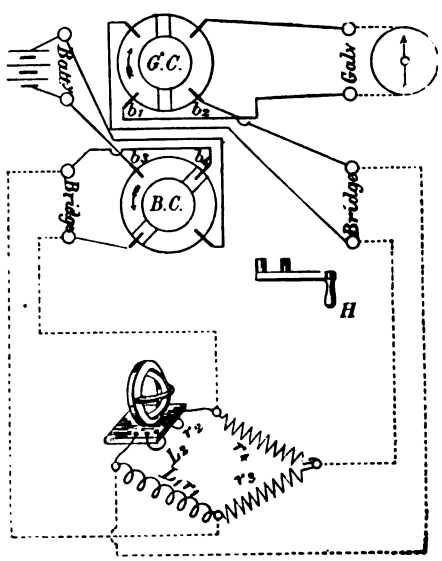

Fig 1.

With the original form of the instrument we proposed to use a speed indicator attached to the rotating spindle, but we pointed out that in some cases it would be desirable to dispense with the speed indicator, especially in view of the difficulty that exists in getting a good cheap speed-indicator; and so most of the measurements that we have to bring before you to-night have not been made in accordance with the first method. We proceeded, not by comparing the coefficient of self-induction in terms of a resistance and a time, but by comparing one coefficient of self-induction with another. You know, of course, if you have a Wheatstone's bridge (Fig. 1) with two wires possessing certain resistances r_1, r_2, and coefficients of self-induction L_1 and L_2, and two other wires possessing resistances r_3 and r_4, but no self-induction, that if you first balance for steady; that is, satisfy the equation

$$\frac{r_1}{r_2} = \frac{r_3}{r_4},$$

you will also have balance for varying currents if in addition you make

$$\frac{L_1}{L_2} = \frac{r_3}{r_4}.$$

The second equation can be fulfilled without disturbing the resistances—that is, without altering the equality of the resistance ratios—if one of the arms contains an apparatus of adjustable self-induction; and further, if the value of self-induction of this apparatus can be read off in secohms for each position of its adjustment we can at once use the secohmmeter for the measurement of a self-induction without the use of a speed indicator.

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In Fig. 1 B C is the commutator for periodically reversing the battery connections, and G C that for periodically reversing the galvanometer connections, the thick lines in the figure representing permanent connections in the secohmmeter itself, and the dotted lines connections temporarily made outside it. When making such a comparison between an unknown and a known coefficient of self-induction, the speed at which the secohmmeter handle, H, is driven need not be known, but the greater the speed the more sensitive the test; the rate of reversal must not, however, be too great for the currents to reach their steady values between two consecutive reversals.

The variable standard of self-induction that we have been employing is a modification of that used by Prof. Hughes and by Lord Rayleigh, and consists of two coils whose planes may be made to have any angle with one another. The speciality of our apparatus is that we have determined the exact value in secohms of the self-induction of the arrangement for various positions of the coils relatively to one another. The values are recorded on the dial fixed to the larger coil, and over which moves the pointer attached to the smaller coils. The instrument thus constitutes a direct-reading variable standard of self-induction.

The wire on both coils is of platinoid, so that the variation of resistance by temperature is practically negligible. The smaller and movable bobbin, which we call A, is wound with 299½ turns; the larger stationary bobbin with two coils, one of 49 turns, which we will call B, and the other of 147 turns, called C. B and C may be used separately or together, so as to help one another, or so as to oppose one another. There are, therefore, four combinations, A and B, A and B − C, A and C, A and B + C, and with each of these arrangements the smaller coil may be turned round through 180deg. The range of the instrument is—

A and B	steadily increasing self-induction from	0·0135 to 0·0175	secohm.
A ,, B − C	,,	0·0157 ,, 0·0229	,,
A ,, C	,,	0·0171 ,, 0·0283	,,
A ,, B + C	,,	0·0215 ,, 0·0365	,,

The total adjustable range is thus from 0·01356 to 0·0365 secohm, or from about 84 miles to 226 miles. It will be observed that the various component ranges overlap one another fully, so that many of the values can be produced with two arrangements, which is convenient for the purpose of checking the accuracy of a measurement. The smallest coefficient of self-induction that can be obtained with the particular standard is by the use of coil B alone, which corresponds with 0·00096 secohm.

The apparatus therefore constitutes a direct-reading secohm standard. Although the coefficient of self-induction of the standard can only be made to have successively progressive values from 0·0135 to 0·0365 secohm, coefficients of self-induction which do not lie between this limit can be measured: for example, suppose the unknown self-induction L_1 of a coil of resistance r_1 ohms be about 0·5 secohm, then we add a resistance r to r_1, so that

$$\frac{r_1+r}{r_2}=\frac{r_3}{r_4}=20, \text{ say,}$$

in which case balance for varying currrents will be obtained when

$$L_1=20\,L_2;$$

and since $20\,L_2$ varies between 0·27 and 0·73 secohm, these limits include 0·5 secohm, and therefore balance can be obtained on rotating the secohmmeter.

The following are some of the results that the students, under the guidance of Mr. Sumpner, have obtained, using the secohmmeter and the adjustable secohm standard just described:—

Coil wound with copper wire 34 millions in diameter, covered to about 48 millions, consisting of 48 layers with 13 convolutions in each layer, wound on a wooden core 2in. thick and 4in. long,

$$L=0{\cdot}0147 \text{ secohm, } r=1{\cdot}34 \text{ ohm, } \frac{L}{r}=0{\cdot}011 \text{ second;}$$

that is, the "time-constant" of this coil is 0·011 second, which is the time required for any current to rise to 0·6321 of its maximum value after it is started in the coil by an application of a fixed P.D. between the ends of the coil.*

Single coils of an ordinary Morse receiver, iron core about 0·31in. thick and 3in. long, outside diameter of coil 0·94in.,

$$L=0{\cdot}0936 \text{ secohm, } r=32 \text{ ohms.}$$

Another single coil of an ordinary Morse receiver, iron core about 0·31in. thick and 3in. long, outside diameter of coil 1·25in.,

$$L=0{\cdot}444 \text{ secohm, } r=50 \text{ ohms, } \frac{L}{r}=0{\cdot}0089 \text{ second.}$$

The resistance of this second coil is only $\frac{5}{7}$ that of the former, but its self-induction is over four times as great.

[* For further information on this point the student is referred to "Notes on Alternate Currents," by Dr. J. A. Fleming, *The Electrician*, February 24th, 1888, p. 404.]

The two complete coils of a Morse receiver in series, with iron sole-plate and armature—the armature, however, being rather a small one,

$$L=0{\cdot}265, \; r=14 \text{ ohms, } \frac{L}{r}=0{\cdot}018 \text{ second.}$$

Coil of a low-reading magnifying spring voltmeter wound with copper wire on a brass bobbin, no iron inside, length of coil 2·88in., external diameter 3in., diameter of brass bobbin on which wire is wound 0·38in.,

$$L=1{\cdot}462 \text{ secohm, } r=333{\cdot}5 \text{ ohm, } \frac{L}{r}=0{\cdot}0044 \text{ second.}$$

Single coil of an ordinary Thomson's reflecting galvanometer,

$$L=2{\cdot}56 \text{ secohms, } r=2{,}700 \text{ ohms, } \frac{L}{r}=0{\cdot}0007.$$

Single coil of a very high resistance Thomson's reflecting galvanometer, the coil being of about the ordinary size,

$$L=70 \text{ secohms, } r=100{,}000 \text{ ohms, } \frac{L}{r}=0{\cdot}001.$$

Comparing these two last results, we see that the ratio of the self-induction is about the same as the ratio of the resistances, which is correct, as each ratio is proportional to the square of the number of turns of wire when the coils are of the same size and shape. Hence the time-constants are about the same.

An ordinary Ruhmkorff induction coil intended to give a 2-inch spark,

Secondary coil, $L=51{\cdot}2$ secohms, $r=5{,}700$ ohms,

co-efficient of mutual induction, 0·46 secohm.

Ferranti dynamo intended to give 200 volts and 40 amperes,

Armature, $L=0{\cdot}0013$ secohm for one phase,

$=0{\cdot}0011$,, for another phase,

when no current is passing through the field-magnets.

Field-magnets in series $L=0{\cdot}61$ secohm for a small excitation, $r=3$ ohms.

Mather and Platt shunt dynamo, intended to give 100 volts and 35 amperes:

Armature from brush to brush,

$L=0{\cdot}005$ secohm, $r=0{\cdot}215$ ohm.

Field-magnets in series,

$L=13{\cdot}6$ secohms for a small excitation, $r=44$ ohms.

When there is iron in a coil the value of the self-induction depends, of course, on the strength of the current employed when making the observation, and on the way in which this current is varied for determining the self-induction. This will be found very fully worked out, with numerous experimental illustrations, in a Paper by Mr. Sumpner, "On the Variation of the Coefficients of Induction" (*Proc.* Phys. Soc., Vol. IX., Part III., for July, 1888). The following are illustrations of the sort of results obtained:—

Experiments on the Self-Induction of a Kapp and Snell 2 horse-power Transformer.

Through one of the circuits of the transformer of approximate resistance 0·07 ohm a current was passed, which was made to have successively the values shown in the Table on next page. On changing its value great care was taken that the change was steadily in one direction without any fluctuations. The self-induction of the other circuit of the transformer of approximate resistance 0·14 ohm was measured in two distinct ways. With the first method the secohmmeter was employed to rapidly alternate a small current of 0·01 ampere through this circuit, while with the second method the self-induction of this circuit was measured by starting a small current of 0·037 ampere through this circuit. After stopping this current the iron was made to go through the complete magnetic cycle before making the next observation or even repeating the former. For instance, supposing the previous measurement was made by starting a current of 0·037 ampere through the one circuit when the steady current through the other circuit was −2 amperes, then on stopping the current of 0·037 ampere the current through the other circuit was first increased up to +10 amperes, then diminished to −10 amperes, and lastly increased up to −1 ampere, for which value the next observation was made.

As has been already pointed out, the presence of iron in a circuit causes the self-induction of that circuit to have very different values; and, further, it causes the value of the self-induction to depend on the rate on which any particular change in the magnetic induction is effected. For example, if the current through one circuit of the transformer be kept quite constant, and the secohmmeter be used to alternate a definite small current through the other circuit, the value of the cyclical self-induction diminishes somewhat as the speed of alternation is increased.

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Currents Steadily Increasing from Minus to Plus.

Steady Current in one Circuit, in amperes.	Cyclical Self-Induction of the other Circuit, in secohms.	Self-Induction of the other Circuit, in secohms, measured by starting a small positive current in this circuit.
−8	0·010	·008
−6	...	0·016
−4	...	0·036
−2	...	0·100
−1	...	0·156
0	0·030	0·216
+1	...	0·264
+2	...	0·260
+4	...	0·064
+6	...	0·016
+8	0·010	0·016

Currents steadily Diminishing from Plus to Minus.

Steady Current in one Circuit, in amperes.	Cyclical Self-Induction of the other Circuit, in secohms.	Self-Induction of the other Circuit, in secohms, measured by starting a small negative current in this Circuit.
+8	0·010	0·008
+6	...	0·012
+4	...	0·028
+2	...	0·092
+1	...	0·144
0	0·030	0·208
−1	...	0·264
−2	...	0·240
−4	...	0·092
−6	...	0·048
−8	0·010	0·020

When we had the honour of first bringing the secohmmeter to your notice in 1887, we exhibited certain curves (Fig. 3, p. 307, *Jour. Soc. Tel. Eng.*, Part 67, Vol. XVI., 1887) showing the apparent increase of resistance of a circuit containing no iron when the secohmmeter was turned at different speeds, and certain other curves (Fig. 4, page 310) for the apparent increase of resistance when an iron core was inserted in the coil. The first set of curves are straight lines, while the second show a distinct curvature. This curvature we attributed at the time to the fact that with high speeds of the secohmmeter the time-constant of the circuit when the iron core was inserted was too large for the current to reach its steady value when the battery circuit was closed, or for the current to die away when it was opened. But on Mr. Sumpner's subsequently attacking this subject both experimentally and theoretically, he found that the increase of the time-constant produced by the insertion of the iron was not sufficient to explain the large amount of bending of the curves. Hence we concluded at the beginning of 1888 that the bending was mainly due to a magnetic lag. At about the same time we obtained evidence that when the speed of the secohmmeter was *very great*, and the lead very small, the insertion of the iron core in a coil actually diminished the self-induction of the circuit—a result that we feared at the time must be due to some defect in the coil, but which the recent investigations of Dr. Lodge now show to be quite possible. This subject we are at present investigating further.

Some time ago we drew attention to the fact that the accuracy of the measurement by means of a wattmeter of the power given by an alternate current to a circuit possessing self-induction depended on the relative values of the time-constant of the fine-wire circuit of the wattmeter and the time-constant of the circuit the power given to which it was desired to measure.

Our result was criticised by Mr. Blathy in *The Electrician* for April 6th, 1888, who made certain calculations regarding the use of the wattmeter constructed by Messrs. Ganz and Co., tending to show that the correction pointed out by ourselves was an unimportant one. We take the opportunity of drawing Mr. Blathy's attention to the fact that in his calculations he has underestimated the value of the self-induction of the suspended coil, and—what is equally important—neglected altogether the self-induction of the so-called non-inductive portion of the fine-wire circuit. Taking the actual specimen of the wattmeter we possess, we find that the suspended coil of resistance 2 ohms has a self-induction 0·00042 secohm. This is about twice what Mr. Blathy allows for it. Further, two of our students—Messrs. Lamb and E. W. Smith—on making a calculation as to the self-induction of the very carefully *doubly-wound* resistance coil of some 980 ohms which is placed in the fine-wire circuit, find that it is 0·00025 secohm, which is more than half the value of the inductive coil And if, in the hypothetical case taken by Mr. Blathy, a *doubly-wound* resistance coil of 100,000 ohms be employed, made of the same wire as is used in the coil of 980 ohms—and this would be necessary, since, the suspended coil remaining the same, the current-density in the high-resistance circuit must remain constant—they find that the self-inductance of the *doubly-wound* resistance will be 0·025 secohm ; so that the self-induction of the high-resistance circuit will be about one hundred times as great as is supposed by Mr. Blathy.

For the purpose of enabling practical men to calculate the self-induction of *doubly-wound* coils made of conducting wire of diameter *d*, covered to a diameter D, and placed parallel to one another, with their insulating coverings in contact, we give the following formula :—

$$\text{L, in secohms, } = \frac{422 \times \log_{10} \frac{D}{d} + 173}{10^9}$$

× total length of going and return wire in yards.

(To be continued.)

THE POST OFFICE AND THE TELEPHONE COMPANIES.

The following letter has been addressed by the Post Office to the United Telephone Company, in continuation of the correspondence already published :—

General Post Office, London, June 21.

Sir : I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 14th inst. replying to my communication of the 4th on the subject of the amalgamation of the telephone companies.

Mr. Raikes cannot admit that there is any room for controversy on the statement that the amalgamation was not contemplated by the Department, and he observes that, as regards the companies themselves, so far from its being shown that amalgamation was in contemplation when the licenses were issued, it is now expressly admitted that it was the policy of the United Telephone Company to parcel out the country amongst subsidiary companies and to confine the operations of these companies to particular districts.

Both by the companies and by the Department it was expected that here and there the companies would purchase some small exchange established by local enterprise, and also that they would occasionally erect a line and sell it outright to the user, instead of leasing it on an annual rental.

The clause to which you refer provides that on such transactions the Department shall not claim royalty. The clause was drawn not by the solicitor to the Department, but by the solicitor of the companies, whose object, as then avowed, was to protect the companies against a double payment of royalty. It had nothing to do with the question of an amalgamation of the United Telephone Company with its subsidiary companies, and cannot be regarded as evidence of amalgamation having been in contemplation.

The Postmaster-General does not, consequently, see any ground for departing from the views expressed in my letter of the 4th inst.

Mr. Raikes must decline at this moment to be drawn into any further controversy with the United Telephone Company upon this question, although he has felt it his duty to make them and the public acquainted with the views which he entertains regarding the projected amalgamation.

I am, Sir, your obedient servant,

S. Arthur Blackwood.

The Secretary, United Telephone Company.

BOOKS, &c., RECEIVED.

"Illustrated Catalogue of Electric Light Fittings." (London : H. Harrison and Co.)

"Système de Traction Électrique," par A. Bandsept. (Bruxelles Co., Imprimerie Belge.)

"Inducteurs Dynamo-Électriques," par A. Bandsept. (Bruxelles Co., Imprimerie Belge.)

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, June 28th.

Society of Arts.

8:30 p.m. Conversazione at the South Kensington Museum.

MONDAY, July 1st.

Royal Institution.

5 p.m. General Monthly Meeting.

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The Electrician.

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications*

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SPECIAL NOTICE.

Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

	3 months.	6 months.	12 months.
	s. d.	s. d.	s. d.
For Foreign Parts and Colonies:—			
Within Postal Union	6 6	12 6	24 0
Aden, Borneo, Ceylon, China, India, Japan, Java, Labuan, Mozambique, New Caledonia, Persia, Philippine Islands, Siam, Transvaal, and Zanzibar	7 6	14 6	28 0
The rates for the United Kingdom remain as follows:—	5 0	10 0	19 6

TO ADVERTISERS.

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TRADE ADVERTISEMENTS *intended for the current issue must be handed in not later than First Post on Thursday morning.*

SMALL PREPAID ADVERTISEMENTS *(for Rates see page xi.) are accepted up to 4:30 p.m. on Thursday.*

TECHNICAL PRINTING.

"THE ELECTRICIAN" PRINTING AND PUBLISHING COMPANY (LIMITED) *beg to inform Electricians, Electric Light Engineers, &c., that they make a specialty of Technical Printing, and have a Staff thoroughly acquainted with Electro-Technology. They can, therefore, promise Accuracy and Despatch in the Printing of Electrical Catalogues and Electro-Technical Literature generally.*

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THE DIRECTORY for 1889 is NOW READY,

And the issue for 1890, which will be still further enlarged and improved, is in preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded to the Publishing Office, 1, Salisbury-court, Fleet-street, London, E.C.

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THE MODEL ORDER AND ELECTRIC LIGHTING INSPECTORS.

Beyond question the most important feature of the "Model Form of a Provisional Order for a Metropolitan Area" is to be found in the relation which it establishes, or seeks to establish, betwixt the Supply Companies on the one hand and the County Council, the Local Authorities, and the Board of Trade upon the other. As the inheritors of the duties and responsibilities of the late Metropolitan Board of Works it was necessary that the County Council should henceforth occupy a prominent position in all Orders relating to the Metropolitan area; but we are unable to consider it either necessary or wise, and we are even surprised to learn that it is within the power of the Board of Trade, to transfer to the Council *en bloc* the important duties which have hitherto been assigned to the local authorities, as well as certain other powers which had been rightly reserved to itself. In future no overhead wire is to be erected in the Metropolis (for electric lighting purposes) without the consent of the County Council. The County Council is to appoint "competent and impartial persons to be electric inspectors for the purpose of inspecting electric lines and works, *and of certifying meters.*" The County Council (and not as hitherto the Board of Trade) is to determine the number of testing stations which the Undertakers will be required to erect at their own expense. (We may add parenthetically, as showing the beautiful simplicity and perfection of the arrangements, that the instruments are to be approved by the Board of Trade, that they are to be used by the County Council's Inspector, that it is expressly provided the Undertakers may look on, but must not interfere, even if the Inspector breaks down the circuit, and finally, that it is provided that any dispute arising out of the action of the Inspector is to be settled, not by the Board of Trade, but by arbitration). Once more, as indicating the singular and the almost painful subservience to the County Council which for some inscrutable reason the Board of Trade seems bent on showing whenever opportunity arises, we may instance the following. Hitherto it has always been customary to insert a clause providing that if the local authority fail to appoint an Inspector, *or if the duties devolving upon the Inspector be imperfectly attended to by the local authority*, the Board shall, if it sees fit, itself appoint a competent and impartial person to

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the post. This provision we regard as a valuable safeguard; but in the Model Order, now that the local authority has been superseded by the County Council, the sentence italicised above is altogether omitted!

We have already had occasion to observe—and we believe that in so doing we are expressing the opinion of every competent and impartial person who is acquainted with the real position of Central Station electric lighting—that whilst it will ultimately be a great and obvious advantage to have the administration of the Electric Lighting Acts in the metropolitan area as far as possible consolidated under one authority, yet for the time being, and until the business has got into something like working order, it is for many reasons preferable that the existing local authorities should continue to exercise their discretion under the paternal oversight of the Board of Trade. The varied experience which would be gained under the administration of the Vestries would, at the end of a couple of years or so, form an invaluable fund of information from which the County Council would readily be enabled to frame a wise and sensible policy. In short, the Council will at that time be in a position to know something of the nature of the business which they are undertaking, whilst at present they are absolutely in the dark, and although it is true that the Vestries are not very much more enlightened, yet if they blunder it will be on a smaller scale, and they will probably have no difficulty in finding examples in other districts by which to be guided. We are strongly of opinion that it is to be desired that the Board should rather extend the limits of its supervision than that it should divest itself of its powers in favour of the County Council, or of any one else. In omitting all mention of the Electric Lighting Acts in the Act which created the County Council, it has hitherto been believed that it was the distinct intention of Parliament to allow some time to pass away and experience to be gained before the Council was entrusted with these powers. It is, therefore, somewhat of a revelation to us to learn that the matter rests wholly at the discretion of the Board of Trade.

There is, however, another question—one of admitted difficulty—in which as touching the whole Kingdom the interests at stake are of even more importance, and on which we think that the policy of the Board of Trade from the very beginning demands reconsideration. We refer to the duties and emoluments which are assigned to the local Inspectors. These persons are to test mains for insulation and conductivity; "if and when required to do so by any person supplied with energy by the Undertakers," they are similarly to test the service lines; they are to examine and record the readings of the instruments to be set up by the Undertakers at the Testing Stations, and they are to furnish reports to the Undertakers, as well as to the "authority or person by whom he was required to make such testing," whilst it is provided that the Board of Trade shall decide any dispute which may arise out of such report. So far we raise no objection whatever; no difficulty need be apprehended as to the supply of men fully able to carry out these simple duties, nor should there be any great difficulty as to their instrumental equipment, though at the same time we will remark in passing that the testing (and consequent disconnecting) of a service line, except in case of extreme need, is a proceeding which may be supposed to recommend itself to a County Councillor more forcibly than to an electrical engineer. But we do strongly object to the system of fees which are to be paid to the Inspector (either for his own behoof or for that of the County Council), especially since in certain cases the Undertakers are called upon to pay whether the test proves them to have been in default or not. It even appears that the Inspector may carry out certain tests as often as he pleases, claiming his fee every time. All this urgently demands revision; in its present shape it seems to us flatly unworkable. The Inspector should receive a definite salary, and the Undertakers should contribute nothing save in the shape of fines for default.

There is, moreover, one other duty which the Inspector is to be called upon to perform—which is none else than the testing and certifying of meters. Seeing also that a certified meter loses its certificate by the act of disconnection from the mains, and that every meter ought, at least at first, to be retested at the end of twelve months, it is clear that this will form no small portion of the Inspector's business. Now how are these important duties to be performed? We can scarcely suppose that the Board of Trade seriously contemplates the establishment of an electrical standardising laboratory by every local authority throughout the country. We do not know that eventually something of this kind might not be done, or that at the least a considerable number of branches of the chief laboratory will not come to be established. But for the present we are confronted by the fact that the Board of Trade throws the responsibility entirely upon the local authority. It is true that the County Council has already expressed its eager desire to undertake the work, but it is equally true that it has not the least notion of what it is talking about. We are willing to suppose that when the Board of Trade first came to a conclusion upon this point it was acting under the belief that the inspectors might readily be provided with secondary standards, which could be compared with the meters *in situ*. In the case of direct currents, it is, perhaps, conceivable that a conscientious inspector, with plenty of time at his disposal, might carry out such a test with a degree of accuracy not greatly below what is usually deemed sufficient for commercial purposes. But even this concession cannot be made in the case of alternating meters. Moreover, it must not be overlooked that if a meter is to be tested throughout its range—and if not what is the "certificate" worth?—a period of from 6 to 10 hours at least will be necessary for the test. It is useless to waste time in arguing the point further, though much more might easily be said. We believe that the entire profession will agree with us in saying that if travelling inspectors are expected to certify meters the whole system becomes a transparent farce.

ON MODERN VIEWS WITH RESPECT TO THE NATURE OF ELECTRIC CURRENTS.*

BY PROF. H. A. ROWLAND.

(Concluded from page 175.)

So far we have considered the case of alternating electric current in a wire connecting the inner and outer coatings of a Leyden jar. The invention of the telephone, by which sound is carried from one point to another by means of electrical waves, has forced into prominence the subject of these waves. Furthermore, the use of alternating currents for electric lighting brings into play the same phenomenon. Here, again, the difference between a current of water and a current of electricity is very marked. A sound wave, traversing the water in the tube, produces a to-and-fro current of water at any given point. So, in the electrical vibration along a wire, the electricity moves to and fro along it in a manner somewhat similar to the water, but with this difference; the disturbance from the water-motion is confined to the tube, and the oscillation of the water is greatest in the centre of the tube, while in the case of the electric current the ether around the wire is disturbed and the oscillation of the current is greatest at the surface of the wire and least in its centre. The oscillations in the water take place in the tube without reference to the matter outside the tube, whereas the electric oscillations in the wire are entirely dependent on the surrounding space, and the velocity of the propagation is nearly independent of the nature of the wire, provided it is a good conductor.

* A lecture given at the College of the City of New York, May 22, 1889, before the American Institute of Electrical Engineers.

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We have then in the case of electrical waves along a wire a disturbance outside the wire and a current within it, and the equations of Maxwell allow us to ca'culate these with perfect accuracy and give all the laws with respect to them.

We thus find that the velocity of propagation of the waves along a wire, hung far away from other bodies and made of good conducting material, is that of light, or 185,000 miles per second, but when it is hung near any conducting matter, like the earth, or inclosed in a cable and sunk into the sea, the velocity becomes much less. When hung in space, away from other bodies, it forms, as it were, the core of a system of waves in the ether, the amplitude of the disturbance becoming less and less as we move away from the wire. But the most curious fact is that the electric current penetrates only a short distance into the wire, being mostly confined to the surface, especially where the number of oscillations per second is very great.

The electrical waves at the surface of a conductor are thus, in some respects, very similar to the waves on the surface of water. The greatest motion in the latter case is at the surface, while it diminishes as we pass downwards and soon becomes inappreciable. Furthermore, the depth to which the disturbance penetrates into the water increases with increase of the length of the wave, being confined to very near the surface for very short waves. So the disturbance in the copper penetrates deeper as the waves and the time of oscillation are longer, and the disturbance is more nearly confined to the surface as the waves become shorter. I have recently made the complete calculation with respect to these waves, and have drawn some diagrams to illustrate the penetration of the alternating current into metal cylinders. The right-hand curve, Fig. 1, represents the current at different depths in a copper cylinder 45 centimetres diameter, or an iron one 14⅓ centimetres diameter, traversed by an alternating current with 200 reversals per second. That and the middle curve show us the current at two different instants of time, and show us how the phase changes as we pass

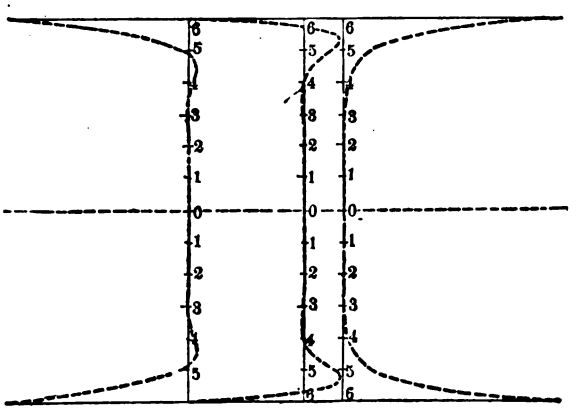

FIG. 1.—Penetration of alternating current in a round solid conductor.

downward into the cylinder. By reference to the middle curve we see that it may be even in the opposite direction in the centre of the cylinder from which it is at the surface. The third figure gives us the amplitude of the current oscillations at different depths, irrespective of the phase, and it shows us that the current at the centre is only about 10 per cent. of that at the surface in this case. The second diagram, Fig. 2, shows us the distribution in the same cylinders when the number of reversals of the current is increased to 1,800 per second. Here we see that the disturbance is almost entirely confined to the surface, for at a depth of only 7 millimetres the disturbance almost entirely vanishes.

There are very many practical applications of these theoretical results for electric currents. The most obvious one is to the case of conductors for the alternating currents used in producing the electric light. We find that when these are larger than about half an inch diameter they should be replaced by a number of conductors less than half an inch diameter, or by strips about quarter of an inch thick, and of any convenient width. But this is a matter to be attended to by the electric light companies.

Prof. Oliver J. Lodge has recently, in the B. A., drawn attention to another application of these results—that is, to lightning rods. Almost since the time of Franklin, there have been those who advocated the making of lightning rods hollow in order to increase the surface for a given amount of copper. We now know that these persons had no reason for their belief, as they simply drew the inference from the fact that electricity at best is on the surface. Neither were the advocates of the solid rods quite correct, for they reasoned from the fact that electricity in a state of steady flow occupies the whole area of the conductor equally. The true theory, we now know, indicates that neither party was entirely correct and that the surface is a very important factor in the case of a current of electricity so sudden as that from a lightning discharge. But increase of surface can best be obtained by multiplying the number of conductors, rather than making them flat or hollow, and, at the same time, Maxwell's principle of inclosing the building within a cage can be carried out. Theory indicates that the current penetrates only one-tenth the distance into iron that it does into copper. As the iron has seven times the resistance of copper, we should need seventy times the surface of iron that we should of copper. Hence I prefer copper wire about a quarter of an inch diameter and nailed directly to the house without insulators, and passing down the four corners, around the eaves and over the roof, for giving protection from lightning in all cases where a metal roof and metal down spouts do not accomplish the same purpose.

Whether the discharge of lightning is oscillatory or not does not enter into the question, provided it is only sufficiently sudden. I have recently solved the mathematical problem of the electric oscillations along a perfectly-conducting wire joining two infinite and perfectly-conducting planes parallel to each other, and find that there is no definite time of oscillation, but that the system is capable of vibrating in any time in which it is originally started. The case of lightning between a cloud of limited extent and the earth along a path through the air of great resistance is a very different problem. Both the cloud and the path of the electricity are poor conductors, which tends to lengthen the time. If I were called on to estimate as nearly as possible what took place in a flash of lightning, I would say that I did not believe that the discharge was always oscillating, but more often consisted of one or more streams of electricity at intervals of a small fraction of a second, each one continuing for not less than $\frac{1}{100000}$ second. An oscillating current with 100,000 reversals per second would penetrate about $\frac{1}{60}$in. into copper and $\frac{1}{600}$in. into iron. The depth for copper would constitute a considerable proportion of a wire ¼in. diameter, and, as there are other considerations to be taken into account, I believe it is scarcely worth while making tubes, or flat strips, for such small sizes.

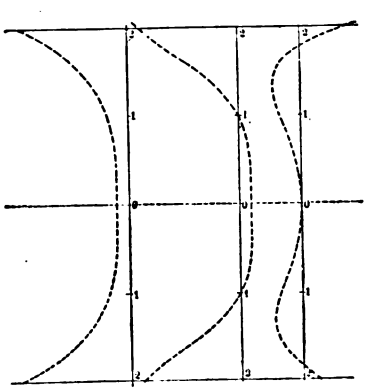

FIG. 2.—Penetration of alternating current in a round solid conductor.

It is almost impossible to draw proper conclusions from experiments on this subject in the laboratory, such as those of Prof. Oliver J. Lodge. The time of oscillation of the current in most pieces of laboratory apparatus is so very small, being often the $\frac{1}{10000000}$ of a second, that entirely wrong inferences may be drawn from them. As the size of the apparatus increases the time of oscillation increases in the same proportion, and changes the whole aspect of the case. I have given $\frac{1}{100000}$ of a second as the shortest time a lightning flash could probably occupy. I strongly suspect it is often much greater, and thus departs even further from the laboratory experiments of Prof. Lodge, who has, however, done very much towards drawing attention to this matter and showing the importance of surface in this case. All shapes of the rod with equal surface are not, however, equally efficient. Thus, the inside surface of a tube does not count at all. Neither do the corrugations on a rod count for the full value of the surface they expose, for the current is not distributed uniformly over the surface; but I have recently proved that rapidly alternating currents are distributed over the surface of very good conductors in the same manner as electricity at rest would be distributed over them, so that the exterior angles and corners possess much more than their share of the current, and corrugations on the wire concentrate the current on the outer angles and diminish it in the hollows. Even a flat strip has more current on the edges than in the centre.

For these reasons, shape, as well as extent of surface, must be taken into account, and strips have not always an advantage over wires for quick discharges.

The fact that the lightning rod is not melted on being struck by lightning is not now considered as any proof that it has done its work properly. It must, as it were, seize upon the discharge, and

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offer it an easier passage to the earth than any other. Such sudden currents of electricity we have seen to obey very different laws from continuous ones, and their tendency to stick to a conductor and not fly off to other objects depends not only on having them of small resistance, but also on having what we call the self-induction as small as possible. This latter can be diminished by having the lightning rod spread sideways as much as possible, either by rolling it into strips, or better, by making a network of rods over the roof with several connections to the earth at the corners, as I have before described.

Thus we see that the theory of lightning rods, which appeared so simple in the time of Franklin, is to-day a very complicated one and requires for its solution a very complete knowledge of the dynamics of electric currents. In the light of our present knowledge the frequent failure of the old system of rods is no mystery, for I doubt if there are a hundred buildings in the country properly protected from lightning. With our modern advances, perfect protection might be guaranteed in all cases, if expense were no object.

So much for the rod itself, and now let us turn to other portions of the electrical system; for we have seen that, in any case, the conductor is only the core of a disturbance which extends to great distances on all sides. Were the clouds, the earth and the streak of heated air called the lightning flash all perfect conductors; we could calculate the entire disturbance. It might then consist of a series of stationary waves between the two planes, extending indefinitely on all sides, but with gradually decreasing amplitude as we pass away from the centre. The oscillation, once set up, would go on for ever, as there would be no poor conductors to damp them. But when the clouds and the path of the lightning both have very great resistance the energy is very soon converted into heat and the oscillations destroyed. I have given it as my opinion that this is generally the case, and that the oscillations seldom take place, but I may be wrong, as there is little to guide me except guess-work. If they take place, however, we have a ready explanation of what is sometimes called a back stroke of lightning. That is, a man at the other end of the cloud a mile or more distant from the lightning stroke sometimes receives a shock, or a new lightning flash may form at that point and kill him. This may be caused, according to our present theory, by the arrival of the waves of electrical disturbance, which might themselves cause a slight shock, or even overturn the equilibrium then existing, and cause a new electric discharge.

We have now considered the case of oscillations of electricity in a few cases, and can turn to that of steady currents. The closing of an electric current sends etherial waves throughout space, but after the first shock the current flows steadily without producing any more waves. However, the properties of the space around the wire have been permanently altered, as we have already seen. Let us now study these properties more in detail. I have before me a wire in which I can produce a powerful current of electricity, and we have seen that the space around it has been so altered that a delicately-suspended magnetic needle cannot remain quiet in all positions, but stretches itself at right angles to the wire, the north pole tending to revolve around it in one direction and the south pole in the other. This is a very old experiment, but we now regard it as evidence that the properties of the space around the wire have been altered rather than that the wire acts on the magnet from a distance.

Put, now, a plate of glass around the wire, the latter being vertical and the former with its plane horizontal, and pass a powerful current through the wire. On now sprinkling iron filings on the plate they arrange themselves in circles around the wire and thus point out to us the celebrated lines of magnetic force of Faraday. Using two wires with currents in the same direction we get these other curves, and, testing the forces acting on the wire, we find that they are trying to move toward each other.

Again, pass the currents in the opposite directions and we get these other curves and the currents repel each other. If we assume that the lines of force are like rubber bands which tend to shorten in the direction of their length and repel each other sideways, Faraday and Maxwell have shown that all magnetic attraction and repulsions are explained. The property which the presence of the electric current has conferred on the luminiferous ether is then one by which it tends to shorten in one direction and spread out in the other two directions.

We have thus done away with action at a distance, and have accounted for magnetic attraction by a change in the intervening medium as Faraday partly did almost fifty years ago. For this change in the surrounding medium is as much a part of the electric current as anything that goes on within the wire.

To illustrate this tension along the lines of force, I have constructed this model, which represents the section of a coil of wire with a bar of iron within it. The rubber bands represent the lines of force which pass around the coil and through the iron bar, as they have an easier passage through the iron than the air. As we draw the bar down and let it go, you see that it is drawn upward and oscillates around its position of equilibrium until friction brings it to rest. Here, again, I have a coil of wire with an iron bar within it with one end resting on the floor. As we pass the current and the lines of magnetic force form around the coil and pass through the iron, it is lifted upwards, although it weighs 24lb., and oscillates around its position of equilibrium exactly the same as though it were sustained by rubber bands as in the model. The rubber bands in his case are invisible to our eye, but our mental vision pictures them to us as lines of magnetic force in the luminiferous ether drawing the bar upward by their contractile force. This contractile force is no small quantity, as it may amount, in some cases, to one or even two hundred pounds to the square inch, and thus rivals the greatest pressure which we use in our steam engines.

Thus the luminiferous ether is, to-day, a much more important factor in science than the air we breathe. We are constantly surrounded by the two, and the presence of the air is manifest to us all; we feel it, we hear by its aid, and we even see it, under favourable circumstances, and the velocity of its motion as well as the amount of moisture it carries is a constant topic of conversation with mankind at large. The luminiferous ether, on the other hand, eludes all our senses, and it is only with imagination, the eye of the mind, that its presence can be perceived. By its aid in conveying the vibrations we call light, we are enabled to see the world around us, and by its other motions which cause magnetism, the mariner steers his ship through the darkest night when the heavenly bodies are hid from view. When we speak in a telephone, the vibrations of the voice are carried forward to the distant point by waves in the luminiferous ether, there again to be resolved into the sound waves of the air. When we use the electric light to illuminate our streets, it is the luminiferous ether which conveys the energy along the wires as well as transmits it to our eye after it has assumed the form of light. We step upon an electric street-car and feel it driven forward with the power of many horses, and again it is the luminiferous ether whose immense force we have brought under our control and made to serve our purpose, no longer a feeble, uncertain sort of medium, but a mighty power, extending throughout all space and binding the whole universe together, so that it becomes a living unit in which no one portion can be changed without ultimately involving every other portion.

To this, ladies and gentlemen, we have been led by the study of electrical phenomena, and the ideas which I have set forth constitute the most modern views held by physicists with respect to electric currents.

THE ELECTRICAL EXHIBITS AT THE ROYAL AGRICULTURAL SOCIETY'S SHOW AT WINDSOR.

The fiftieth annual exhibition of this Society was opened on Saturday last in Windsor Great Park in fine weather, and will continue open until to-morrow (Saturday). Amongst the numerous exhibitors are most of the well-known engineering firms, but electrical exhibits are conspicuous by their absence—a circumstance greatly to be regretted, as the annual gathering of this Society presents exceptionally good opportunities for bringing before the wealthier classes many articles of an electrical character for inspection and purchase which would otherwise never come under their notice. We feel the less hesitation in saying this as the utmost interest was exhibited in the artistic electric light installation at Messrs. Priestman's Stand (No. 297), which attracted crowds of admiring visitors.

One of the few things electrical on the show ground is Messrs. Immisch's electrical dog-cart (Stand No. 74), which was described and illustrated in *The Electrician* of September 14, 1888. At the Stand of Messrs. Priestman Brothers (No. 297), Messrs. Lea, Sons and Co., of Pengwerne Works, Shrewsbury, have a small electric light installation, and an extremely pleasing exhibit of hammered iron work of exceptionally handsome designs. They show a number of wall brackets, electroliers, and side-lights under the name of "Metalli-Floral Electric Fittings," the beautiful designs of which have only to be seen to be thoroughly appreciated. They are to be congratulated upon their very laudable desire to revive th almost lost art of producing elegant designs in hammered metal. The Acme Electric Works, of Chalk Farm-road, London, at the Griffin Gas Engine Company's Stand (No. 374), and Mr. H. J. Rogers, of Watford Engineering Works (who has an Elwell-Parker plant installed), at Stand No. 293, have small electric light installations; and these seem to exhaust the very limited number of electrical exhibits at the Show.

In the Engineering Section very fine engine and machinery exhibits are made by most of the prominent makers. Messrs. Davey, Paxman and Co. show several of their well-known engines, amongst which is a 16 horse-power compound engine and boiler, fitted with Paxman's patent automatic expansion gear and patent adjustable high-speed governors and feed-pump. Messrs. Robey

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and Co., of Lincoln, have, at Stand No. 1, several of their well-known engines, fitted with their improved high-speed equilibrium governors. Most conspicuous amongst these is a 12 horse-power compound "Robey" engine and boiler, controlled by Richardson's patent governor and link expansion gear, by which the cut-off can be regulated from ⅛ to ⅞ of the stroke, with only slight variations in load. There is also their well-known type of high-speed vertical engine and dynamo combined, suitable for small electric light installations or for ships' lighting, &c. Messrs. John Fowler and Co., of Leeds, exhibit, at Stand No. 4, a 25 horse-power (nom.) compound engine, specially constructed for driving the electric-light installation at Col. North's mansion at Eltham, Kent. The high-pressure cylinder is 10in. and the low-pressure 16in. in diameter by 20in. stroke, with a speed of 120 revolutions per minute. Both cylinders are fitted with Hartnell's patent automatic expansion gear, controlled by one governor. The fly-wheel is grooved for five 1¼in. ropes, and is 10ft. in diameter. The engine is specially constructed for long runs, and has drop-sight lubricators to all the bearings and sight-feed lubricators on both steam chests We hope to give further particulars of this engine in a future issue. Messrs. Fowler also show an 8 horse-power semi-portable engine and one of Scott's convertible high-speed engines, both suitable for electric-light work, and they have on view some specimens of Tatham's well-known lead-covered wire for telephones and electric light. Messrs. Ransomes, Sims and Jefferies, of the Orwell Works, Ipswich, show a number of engines at Stand No. 275, amongst which is a 10 horse-power compound "undertype" engine and a 16 horse-power long-stroke stationary engine, with patent automatic expansion gear; the latter is a fine specimen of engineering work, and is specially constructed for driving machinery where high efficiency and great regularity of speed is required. At Stand No. 312, Messrs. Marshall, Sons and Co., of Gainsborough, exhibit a 12 horse-power stationary engine, with Hartnell's gear and Marshall's speed indicator, and a number of their well-known portable and traction engines. Messrs. Richard Hornsby and Sons (Limited), of Grantham, exhibit at Stand No. 278 a 10 horse-power "underneath" high-pressure vertical engine, suitable for use where space is limited and where keeping the crank-shaft low down is an advantage; these engines require very little foundation, and are easily removed. Other exhibitors in this section are Messrs. Clayton and Shuttleworth, of Lincoln, who have on view a 12 horse-power compound engine, fitted with Tyrell and Deed's patent governor; Messrs. Ruston, Proctor and Co., of Lincoln; Messrs. E. R. and F. Turner, of Ipswich; Messrs. Weyman and Johnson, of Guildford; Mr. E. S. Hindley, of Bourton, Dorset; Messrs. Charles Burrell and Sons, of Thetford, who show a 16 horse-power "undertype" engine, fitted with automatic expansion gear controlled by the governor, being specially adapted for driving electric-lighting machinery; Messrs. J. and H. Maclaren, of Leeds; Messrs. Woods and Co., of Stowmarket; Messrs. Brown and May, of Devizes; Messrs. Edward Humphries (Limited), of Pershore; Messrs. W. H. Nicholson and Sons, of Newark-on-Trent; Messrs. Farmer, Robey, Clark and Co., of Gainsborough; Messrs. Richmond and Chandler, of Manchester; and Mr. Alfred Dodman, of King's Lynn. The display of engines of all kinds is a very large one, and it is probable that never before were so many on view at one time.

A number of gas-engines are exhibited, amongst which Messrs. Crossley Brothers' well-known "Otto" type occupies a conspicuous place. They show at Stand No. 375 a 9 horse-power horizontal and a 3 horse-power vertical engine with hoist gear attached. This firm has recently substituted for the old-type slide arrangement a tube igniter; they claim that this is a most important improvement and effects a great saving in gas. They have also introduced a new pendulum governor, by means of which strap and wheel are dispensed with. This arrangement is very ingenious and simple. At Stand No. 374 the Griffin Gas Engine Company exhibit a number of their engines, one of which is driving a Royce dynamo at the small but effective electric-light installation of the Acme Electric Works mentioned above. Amongst other exhibitors of gas-engines are Messrs. J. E. H. Andrew and Co., of Redditch, who show the "Stockport" and "Bischoff" engines; the British Gas Engine and Engineering Company (Limited), who have on view the Atkinson "Cycle" engine; the Beck Gas Engine Company, and the Campbell Gas Engine Company.

Oil-engines find a place among the exhibits, the most important being undoubtedly those at Stand No. 297, shown by Messrs. Priestman Bros., of Hull and London. These engines are of the latest type, and comprise a 6 horse-power (nominal) portable engine, the special feature of which is the application of this motive-power to a portable engine, this being its first introduction to the general public. Messrs. Priestman claim that they are able to use common mineral oils with their engines, that no driver is required, and that but little attention is necessary. They have also on view a 4 horse-power (nominal) horizontal engine, which is used to drive a 50-light dynamo for Messrs. Lea, Sons and Co.'s installation of the electric light already referred to. The general design of this engine has recently been much improved as to compactness, &c., and it is now so constructed that every part is easily accessible. A 1 horse-power engine similar to the foregoing is also shown, fitted with an air-compressor mounted upon a sole-plate at the end of the engine and connected directly by gearing. This engine is suitable for pumping, &c. An improved method of supplying electricity for igniting purposes by means of a small storage cell is likewise exhibited, the advantage of which will be readily seen, as the cell will last for about three months without being recharged. Messrs. Priestman inform us that they have orders for a large number of these engines, both for home and export. Another oil-engine is that shown at Stand No. 296 by Mr. J. H. Knight, of Barfield, Farnham, who claims for his engine that it will be found very useful for small electric-light installations or for driving ventilators, it occupying only a small space. We understand that Messrs. Brown and May, of Devizes, will shortly undertake the manufacture of these engines. At Stand No. 295 is an oil-engine made by Mr. G. W. Weatherhogg, of Swinderley, near Lincoln, which is not at work, but for which it is claimed that it is not liable to accident by explosion and is silent and economic in working.

Several turbines are exhibited, conspicuous amongst which are those shown by Mr. C. L. Hett, of Brigg; Mr. H. P. Vacher, of Winchester; Messrs. G. Gilkes and Co., of Kendal; and Mr. C. Cadle, of Wellington Quay, Dublin.

Amongst other exhibitors may be mentioned the Blackman Ventilating Company, who show their well-known ventilating fans; Messrs. W. H. Willcox and Co., of Southwark-street, London, S.E., who have a fine display of engineers' stores, &c.; Messrs. W. F. Dennis and Co., of Leadenhall-street, who show a number of specimens of fencing wire, &c., manufactured by Messrs. Felten and Guilleaume, of Mülheim. There are exhibits of driving bands of all kinds, pulleys, &c., by the best-known makers.

Speaking of the Show as a whole, it is undoubtedly one of the largest and best the Society has ever held, and, with a continuance of fine weather, we have no doubt that the attendance will exceed that at Nottingham last year, when 147,927 visitors were admitted. As mentioned above, the Show will be open to-day (Friday) and to-morrow, and the large number of interesting exhibits of all kinds will well repay a visit.

After the parade of the cattle before their Royal Highnesses the Prince and Princess of Wales and the Royal Family, on Wednesday, His Royal Highness was graciously pleased to order the electric carriage, exhibited by Messrs. Immisch, at Stand No. 74, to be brought before him by a member of the firm, who explained the principle and action of the mode of locomotion. Their Royal Highnesses all appeared greatly interested in the simplicity of the details and in the ease with which the carriage is driven and guided. The motive force was supplied by accumulators from one of Messrs. Immisch's electric launch-charging stations, now lying in the Thames off Windsor.

LEGAL INTELLIGENCE.

King, Brown and Co. v. The Anglo-American Brush Electric Light Corporation (Limited).

JUDGMENT.

LORD TRAYNER, in the Court of Session, on Wednesday, gave judgment in the action by King, Brown and Co., Rosebank Electric Works, Broughton-road, Edinburgh, against the Anglo-American Brush Electric Light Corporation (Limited), 6, York-place, Edinburgh, for the reduction of the defenders' letters patent respecting series-shunt winding.

His LORDSHIP said: The question to be determined in this case is whether Mr. Brush is the inventor of (1) the peculiar form of commutator, and (2) the series-shunt machine for which the letters patents now under reduction were granted. In regard to both the pursuers maintain that Mr. Brush is not the first and true inventor, and that both had been publicly known and used prior to the date of the letters patent. To some extent the determination of the question at issue depends upon the construction of Mr. Brush's patent obtained in 1878 and the patent obtained by Mr. Varley in 1876, to some extent also on matters of fact which are disputed. A long proof has been laid before me, from which it was not possible at the time to exclude evidence which ultimately resolved itself into expressions of opinion as to the meaning and construction of the two patents. In forming my judgment upon the questions submitted to me, I have carefully considered the proof, in so far as it was necessary thereby to instruct myself on scientific theory and detail, and in that respect I have obtained great assistance from the evidence adduced on both sides. I would like to add that I have been greatly assisted also by a remarkably able argument from both sides of the Bar. But in construing the letters patent I have put aside the different views of the witnesses on both sides, as construction is a matter for the Court and not for the witnesses.

In disposing of the case, I shall deal separately with the questions connected with the commutators and the series-shunt machine.

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First. As regards the commutator, Mr. Brush describes his invention in the provisional specification in these terms:—"In constructing commutators cylindrical with an insulating hub or body, to which are attached metallic sub-segments placed in electrical connection with the general mechanism in which the commutator is employed, and metallic wearing sub-segments detachably attached to said sub-segments." This is said to have been anticipated by Varley's commutator and the Manchester commutator, both of which have been produced. With regard to both of the last-mentioned commutators, I think it may be said that they are cylindrical, with metallic sub-segments having metallic wearing segments detachably attached. They also had an "insulating body," or I should rather say "insulating substance," for the word "body" is ambiguous. Yet with all these points of similarity, I do not regard them as anticipations of the defenders' commutator. The insulating hub or body of the defenders' commutator is the "body" or basis on which his commutator is constructed, to which the various parts of his commutator are attached. This cannot be said of the Varley or Manchester commutator, in which the insulating substance does not form the body or basis of the commutator at all, and insulates not the whole commutator, but only one section of it. The purpose and effect of the Varley and Manchester commutators, electrically considered, were in my view the same as Brush's commutator; but it is not in that view that Brush claims that his commutator is a new invention. He claims it merely as a mechanical device or arrangement having certain advantages over existing arrangements used to serve the same purpose. But as a mechanical arrangement I think it was new and useful, and not open to challenge. But the pursuers maintain that the Letters Patent under reduction are rendered invalid by reason of the patentee claiming in his final specification (as amended and disclaimed) something with reference to this commutator as an invention which is not foreshadowed in the provisional specification. The claim here referred to is the fourth, which is in these terms:—"The commutator having metallic insulating segments, T, substantially as shown in division three." It appears to be necessary, or at least desirable and advantageous, to cut the armature bobbins out of circuit when they are crossing the neutral or current-reversing points of the magnetic field. To do this the continuity of the current-conducting segments of the commutator has to be broken, either by a mere space or by the insertion of some non-conducting material at the given point. The cutting of the bobbins out of circuit was known and practised before the date of the defenders' patent, but it was not before then done by means of an insulated metal segment. The advantage which attaches to the defenders' method is this, that the insulated segment being metal, like the conducting segments, there is insured a uniformity of wear over the entire surface of the commutator, which could not be preserved where a softer material like wood was used, or where merely a space was left. I am not aware that prior to the defenders' patent any insulating body, metal or otherwise, was ever used in the construction of the commutator, for the purpose of cutting the bobbins out of circuit. The insulating segment T of the defenders' patent was therefore a novelty, and its utility I do not understand to be disputed. But was it foreshadowed by the provisional specification? I think not.

In the first place, the defenders' second claim seems to me to be co-extensive with the provisional specification (in so far as it relates to the commutator), so that there was nothing left to claim under another head. If all that was foreshadowed in the provisional specification is included in the second claim, then the fourth claim (unless regarded as mere repetition, which nobody suggests) is for something not there foreshadowed. Secondly, the provisional specification relates only to the construction of a cylindrical commutator, whereas one of the chief purposes of and one of the main advantages to be derived from the insulating segment T, is the preservation or maintenance of the cylindricity of the commutator; an object probably as important and as patentable as, but quite distinct from, the shape or mode of construction. Thirdly, the insulating segment T is not merely or necessarily a part of the cylindrical commutator having sub-segments with wearing segments detachably attached. It has and is intended to have a peculiar function which is not referred to in the provisional specification at all. Fourthly, it is said that the segment T is a part of the wearing segment, and therefore falls within the description of the provisional specification; but I think this is not so. The wearing segment is an essential part of the defenders' commutator; the segment T is not—it may be dispensed with altogether.

I come, therefore, on this part of the case, to the conclusion that the patent sought to be reduced is invalid in as much as the invention claimed in the final specification is larger and different from that claimed in the provisional specification.

It is right, notwithstanding what I have said, that I should also express my opinion upon the remaining question in the case, viz., was Mr. Brush the inventor of the series-shunt machine, or had that invention been anticipated by Varley? For the pursuers it is maintained that Varley disclosed and published the invention of a series-shunt machine in his specification and patent of 1876, and constructed a machine in conformity with that specification which was a series-shunt machine and was publicly used as such in 1877. The defenders' patent as I have said is dated in 878

In considering whether the description given by Varley in his specification amounts to a publication of the invention claimed by the defenders, it is necessary to bear in mind the two different kinds of winding used in dynamos known at the time when Varley's specification was lodged. The first of these was the *series*. In the series machine one wire was coiled round the magnets, and the current sent along this wire served both for the excitation of the magnets and the performance of the external work. There was thus one wire and one circuit. In the second—the *shunt* machine—there was again only one wire coiled round the magnets, but the electricity developed by the machine, instead of being entirely conducted in one circuit (as in the series machine), was bifurcated immediately as it left the machine, and one part went wholly to the excitation of the magnets, while the other went wholly to the performance of the external work. The current was thus divided in two, each part of which formed a branch or circuit quite independent of the other. The defects or weak points in each of these machines has been clearly explained by Mr. Imray and need not here be repeated. These defects found their remedy in the third kind of machine now known as *series-shunt*, which, speaking generally, is a compound of the other two; it is in effect a series machine with a shunt added to it. In this machine the magnets are wound round with two insulated wires, one having a higher resistance (the shunt coil) than the other (the series coil). The electricity produced by the machine is diverted, or bifurcated immediately after it leaves the armature; part of it is taken by the shunt to magnetise the magnets, the remainder of it being conducted by the other wire (the series) so as to (1) excite the magnets, and (2) perform the external work. The shunt-circuit is always closed—the other may be either closed or open. Thus, whether the series-circuit is closed and is exciting the magnets, and doing external work, or is open and conveying no energy, the shunt-circuit is engaged in keeping the magnets sufficiently magnetised. For if the series-circuit is open, the only path from the armature being by the shunt, more of the energy produced in the armature will pass through the shunt-circuit, and the effect of the shunt in exciting the magnets will be increased, thus compensating for the absence of any excitation from the series-circuit. The magnetisation of the magnets is in this manner maintained, so that the machine is kept ready to do full work on the series-circuit being again closed.

I turn now to Varley's description, which, for convenience, I here quote. He says, describing his machine, "Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce the electric light. There are several well-known ways of doing this, but the method I prefer is to wrap the soft iron magnets with two insulated wires, one having a larger resistance than the other. The circuit of large resistance is always closed, and the circuit of less resistance is used for the electric light. When the electric light is being produced, the greater portion of electricity passes through the circuit of less resistance, which I term the 'electric light circuit,' maintaining the magnetism of the magnets and producing the light. When the electric light circuit is opened from any cause, the electricity developed passes through the circuit of greater resistance only, and maintains the magnetism of the magnets."

In this description I find disclosed (1)—That the electricity developed by the machine is diverted or divided, one part going to maintain the magnetism of the magnets, and the remainder going to produce the electric light; (2) that the method by which this may be accomplished (and the method which Varley prefers) is by wrapping the magnets with two insulated wires, one having a larger resistance than the other; (3) that the circuit of larger resistance is always closed, and the current passing through it maintains the magnetism of the magnets, and (4) that the current passing through the circuit of lesser resistance is used for "maintaining the magnetism of the magnets and producing the light." These four things appear to me to comprise every distinctive feature of a series-shunt machine. The series arrangement and the shunt arrangement are combined with the compensating or self-regulating result to which I have already alluded.

The defenders' scientific witnesses all express in their examination-in-chief the opinion that Varley did not disclose or publish the series-shunt arrangement in the description which I have already quoted. They find Varley's description to be inconsistent with series-shunt, and suggestive of something quite different. The value of these opinions, however, is seriously diminished when consideration is given to the method by which they are reached. I think I do the defenders' witnesses no injustice when I say that their method is to take Varley's description paragraph by paragraph, each by itself and detached from the context, and then proceed to show how each separate paragraph is, when so read, inconsistent with, or suggestive of something other than series-shunt. As an example of this method of dealing with Varley's description, I may refer to the evidence of Prof. Silvanus Thompson, the first witness examined by the defenders. Such a method is neither reasonable nor fair. To do justice to Varley's description it must be read in its entirety; and when this is done even Prof. Thompson has to admit, as he does on cross-examination, that the description is "consistent with the series-shunt arrangement," which is just a somewhat guarded way of saying that it is descriptive of a series-shunt arrangement. In like manner (but with a greater degree of fairness) Sir William Thomson deals with the description. He finds that there are some things inconsistent with series-shunt—that he "has been puzzled" in trying to understand the description which contains some words of a misleading rather than instructive tendency, and he concludes that an ordinary skilled workman would not in 1876 by Varley's description "have had disclosed to him the system of series-shunt winding." That opinion certainly undergoes modification in the course of his examination, for he concludes his evidence-in-chief (on this part of the case) by saying that he thinks "it quite probable that in 1876 he (the ordinary skilled workman) might have been led to series-shunt by these descriptions." His cross-examination, however, brings him still nearer to the view which I have taken. He says: "The whole passage is consistent with series-shunt winding except the partial inconsistency of the first lines, which is not an absolute inconsistency." On the whole, I think Sir William Thomson may fairly be claimed by the pursuers as a witness in support of their views.

A great deal of evidence is adduced to show that Varley's description would not have enabled an ordinary skilled workman to construct a series-shunt machine, although some of the defenders' witnesses say that from Varley's description it would have been difficult only—not impossible. But assuming the fact to be that from Varley's description alone the ordinary skilled workman could not have constructed a series-shunt machine, that is by no means conclusive of the question in the defenders' favour. A specification may so insufficiently describe the process or the machine

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patented as to render the patent invalid. It may, nevertheless, contain sufficient description to disclose or publish the invention, so as to prevent its being validly patented by another subsequently; but I think it has been demonstrated that Varley's description was sufficient to enable a workman to make his machine. The model, No. 37, which everyone admits to be a model of a series-shunt wound machine, was made by a lad nineteen years of age, apprenticed to an instrument maker, "from the information derived from Varley's patent with its drawings and from nothing else. It is entirely my own idea of Varley's patent." The same thing was done by others. On the other hand, while there are witnesses brought to say that the description is misleading and inconsistent, no skilled workman has been brought to prove that having tried to make the machine from Varley's description he had been unable to do so.

It is further urged by the defenders that Varley had not, when he invented his machine, any knowledge of the value of series-shunt, and particularly of the quality of "constant potential," which by a series-shunt machine alone of the three I have mentioned can be approximately obtained; that series-shunt was not in his mind, but some method of series-winding with a separate coil for separate excitation; that, on the other hand, Brush knew the value of, and was seeking to find, a self-regulating machine. These matters have not, in my mind, any very direct bearing on the question at issue, but they require to be noticed. In the first place, Varley deposes that in making his specification he "understood the electrical significance of series-shunt winding" and I believe him. It is only due to Mr. Varley that I should say, that whatever may be the soundness or otherwise of his electrical theories, there is no doubt in my mind of his honesty. When he speaks to facts I think he may be entirely relied on. In the second place, whatever value Varley placed on the compound winding of his machine, it was not in his view to make a machine which should proceed on the principle of separate excitation within the machine itself. He made a drawing (No. 40 of process) in November, 1876 (before the date of his provisional specification), which shows that he intended his machine to be a series-shunt, and not a series with separate excitation. With regard to that drawing, Prof. Silvanus Thompson says:—"So far as that drawing goes it indicates a series-shunt arrangement." In the third place, without expressing any opinion as to what may have been the state of knowledge of either Varley or Brush before 1876 or 1878, as to the value of "constant potential," it is certain that neither of them in their respective specifications say anything to indicate their appreciation of the value of the quality, or disclosed any view whatever as to the mode in which it was to be obtained. Even in 1878 constant potential was not felt to be a desideratum in electric machines, and in regard to this matter Varley and Brush for all that appears stand on an equal footing.

Lastly, on this branch of the case, I have to notice that the defenders rely very much upon the fact that Varley in his specification did not claim the invention of compound-winding. But Varley explains why he did not do so, and I have no doubt his explanation is true. Perhaps he was too timid; perhaps he had given a construction and attributed a value to his brother's communication which it would not bear and did not merit. And yet it appears that another skilled electrician at first reading took the same view of that communication which Varley did. But the fact that Varley did not claim a certain invention is no proof that he did not publish it.

I come now to the question whether the defenders' machine was anticipated by user.

A machine was constructed under Varley's specification, in 1876 or 1877, which is produced. I think it is proved to be a series-shunt machine. It has the two coils of wire round the magnets, one of greater resistance than the other, and was capable undoubtedly of being worked as a series-shunt, having an appropriate commutator for that purpose. But some of the defenders' witnesses say it was a merely experimental machine and could be connected in a variety of ways. It was certainly not worked as a series machine with separate excitation, for the commutator used was quite inappropriate to, and negatived the idea of such use. How was it connected? Varley says: "The machine, No. 29, was connected exactly in the way that is represented by that diagram." (No. 40.) Sir William Thomson says that that diagram (*Electrician*, December 7, 1888, p. 140) represents series-shunt. He is asked, "If you were told as a fact that this machine had been connected in accordance with the device shown in that sketch, would that convey to your mind a certainty that this machine had been worked as a series-shunt machine?"—And he answers, "Yes." There are other signs spoken to, which, in the opinion of some of the witnesses, indicate that the machine was worked as a series-shunt; but there are contrary opinions also. I rely upon the evidence of Varley that his machine, which was undoubtedly capable of being connected and worked as a series-shunt, was so connected and worked. He knew best how his machine was connected, and as I have said, on any matter of fact, I have no doubt of Varley's accuracy and truthfulness. Then, if it was so worked, it was worked publicly. It was used publicly to illustrate certain operations in a diving tank and for the purpose of photographing an ice machine. These were not experiments on the machine itself. They were the application of the machine to business purposes, made in the presence of the public, without secrecy or concealment. Very little use of a machine in such circumstances will constitute prior use. "If it is proved distinctly," said Lord Lyndhurst, "that a machine of the same kind was in existence, and was in public use—that is, if use or if trials had been made of it in the eye and in the presence of the public, it is not necessary that it should come down to the time when the patent was granted. If it was discontinued, still that is sufficient evidence of the prior use so as to invalidate the letters patent." Such use of Varley's machine is, I think, distinctly proved. I am of opinion that the defender's machine was anticipated by Varley's, both by publication and use, and that the defender's patent is therefore invalid. I therefore give decree as applied for, with expenses.

Judgment accordingly.

Fyfe v. the Pilsen-Joel and General Electric Light Company (Limited).

This case came before Mr. Justice Mathew, without a jury, last week. It was a claim by the plaintiff for money expended by him as acting member of a committee of investigation, which was appointed last year to inquire into the state of the company, the defence being that such expenditure was unauthorised.

Mr. Kennedy, Q.C., and Mr. T. W. Chitty appeared for the plaintiff: Mr. Scrutton for the defendant.

The plaintiff stated the circumstances under which the committee of investigation, consisting of himself, Mr. Gwynne, Mr. Hopkins, and Mr. Hutton, were appointed, and they were to report to an adjourned meeting in a month. The company had three installations in London in different places, and several miles of wires; the gross income was about £5,000 or £6,000 a year. The committee at the first meeting arranged the programme, to take stock, go through the books, have them written up—and generally ascertain the state of the company's affairs. It would have been utterly impossible for the committee without employing technical assistance to prepare their report within the time named. Mr. Elworthy was employed to take stock, and was paid £50. He gave particulars of the persons employed and also the work they did. One gentleman he had paid £30, though he had only charged £15.

Mr. HUTTON and Mr. HOPKINS gave corroborative evidence, and a deal of correspondence was read. Mr. Hutton said he had not authorised the employment of a valuer and an accountant; he should, no doubt, have done so had he been asked, but he said, when appointed, that he could not give much time to the investigation.

Evidence was also given by some of the gentlemen who did the work in question.

On behalf of the defendants, Mr. W. H. TRENTHAM, formerly secretary to the company, and now one of the voluntary liquidators, was called to state that in February of the present year the stock had been taken, being practically the same as it was in March, 1888, and a charge of 25 guineas only made.

Mr. GWYNNE said he was nominated one of the committee of investigation, but took no part in the proceedings. He was not aware the committee were incurring any expenses. In one of his letters to the plaintiff he referred to the necessity for the stock being valued by an electrician, but he thought the plaintiff would do it himself, or send one of his assistants to do so.

Sir RAWSON W. RAWSON said he was chairman of the company until February of the present year. In the report issued to the shareholders in March, 1888, there was a recommendation that the item of £25,000 appearing in the balance-sheet for goodwill and patent rights should be reduced to £527. In order to ascertain whether that recommendation should be adopted, a stocktaking was not necessary. In his view the intention of the shareholders was that the committee should inquire into the future policy of the company rather than into the past management, but the directors were quite willing that the fullest investigation should be made. The committee were directed to confer with the directors, but no conference was held until either the 5th or 9th of April. If such conference had been held earlier, much of the expenditure could have been saved. When he heard that Mr. Fyfe proposed to have the stock taken, he objected to it as unnecessary. He heard the full details of the expenditure for the first time in court yesterday, except the item of £50 for stocktaking, which he at once stated was preposterous. Up to July 17 plaintiff had made no claim for expenses, but, in prospect of a sale, he then brought in his claim, which the directors objected to. On July 20 the claim was sent in for £100, without any details which the directors asked for, and Mr. Fyfe declined then to give. At the next meeting he produced a Gladstone bag, which he opened, and said it contained the vouchers; the directors declined to examine them, and asked for a detailed statement.

Cross-examined: There was no store clerk and no store ledger. He could not say whether he agreed with Mr. Gwynne that a stocktaking was necessary to a complete report. The details he had given of interviews with plaintiff were not entered in the minutes. He knew in July who had been employed, and he thought that the amount of £100 was preposterous. An injunction was brought by Mr. Fyfe and others to restrain the sale of the company's assets to Mr. Gwynne—a sale to which Mr. Fyfe had previously agreed.

Re-examined: He knew who had been employed, but not what they had been paid.

Mr. SCRUTTON then addressed the Court, and objected that £55. 18s. 6d. of the amount claimed had not been actually paid until after the action was brought.

His LORDSHIP said the writ might be amended by making the claim for "liability incurred," as well as for "money paid.'

Mr. SCRUTTON then argued that there was no liability on the part of the company, and that if there were any liability at all, the proper persons to sue were the committee, and not Mr. Fyfe personally.

Mr. KENNEDY having briefly replied,

His LORDSHIP, in giving judgment, went through the facts of the case, and pointed out that when the claim was first put forward it was not repudiated *in toto* as it had been in court, but particulars were asked for. He held that it must have been intended that the committee should have power to incur any expense necessary in making the investigation, and that it was not unreasonable to employ proper and skilled persons to examine the accounts and take the stock. He could not give effect to any of the technical points raised by the defendants, and he could not say that any of the items charged were unreasonable. He must, therefore give judgment for the plaintiff, with costs.

Judgment accordingly

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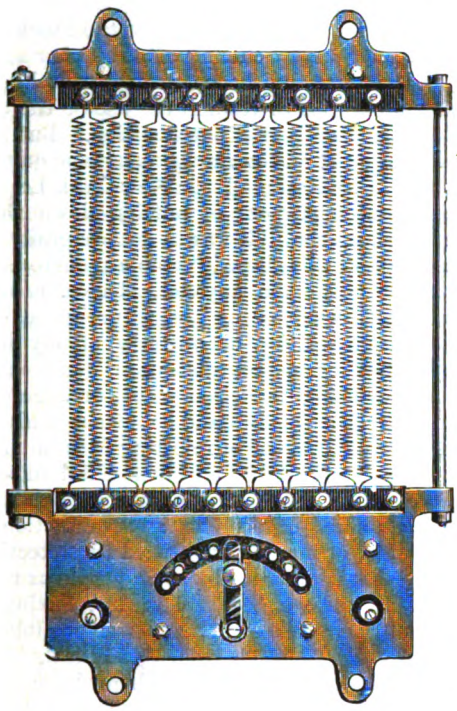
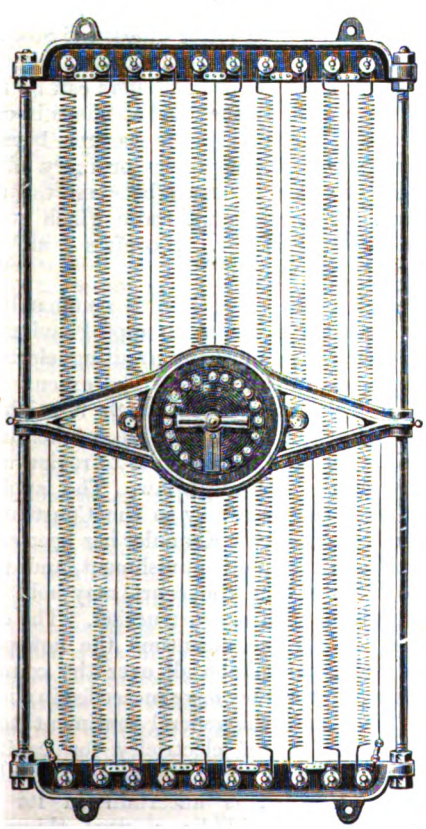
NEW DESIGNS FOR FIRE-PROOF RESISTANCE FRAMES.

The resistance frames illustrated in the adjoining figures have been designed by Messrs. Goolden and Co. to meet the growing



requirements of contractors and central station authorities for means of regulating currents, or for testing purposes. The smaller frame, which is 12in. wide, and of any length up to about 2ft. 6in., according to the resistance required, consists of a cast-iron frame at the



top and bottom, connected by the iron side-rods. These frames are hollow, and have slate slabs fitted in by bolts going right through. The edges of these slabs standing clear of the frame carry the resistance coils, clamped and connected by brass screws and nuts, going right through the slate. A semi-circular opening in the bottom frame allows a series of contact pillars to rise from the slate slab over which the switch passes, cutting in or out resistance.

In the larger pattern the top and bottom frames, made of cast-iron, carry ten wrought-iron pins, cast in the mould, upon which porcelain insulators are secured by split pins; on these insulators the coils are suspended and the ends connected by screwed connectors, from which branch wires are led to the central regulating switch, which is composed of a number of contact pieces mounted on a slate disc, secured by bolts to the cross-frame of iron. This larger pattern is 18in. wide and of varying length up to about 6ft. The coils are made of platinoid, German silver, or tinned or galvanised iron according to the purpose required. The smaller frames may be made for any resistance or current to dissipate up to about 1,000 or 1,200 watts without becoming too hot; the larger frames have been made to dissipate up to about 8,000—10,000 watts. A considerable number of the smaller frames are in use for regulating shunt-wound dynamos or varying the exciting current of alternating dynamos; the larger ones are in use for regulating the charging of sets of accumulators in parallel, regulating motors in transmission of power, &c. These frames satisfy all the requirements of the fire insurance offices, and are very substantially and thoroughly made.

THE WEYMERSCH BATTERY.

The capabilities of the Weymersch battery, as will perhaps be remembered by our readers, were thoroughly tested some twelve months ago by Messrs. Alabaster, Gatehouse and Co., whose report we published at the time (*Electrician*, June 22, 1888, p. 220). These tests showed clearly that M. Weymersch's depolariser was capable of yielding some very good results, one remarkable fact being that the zinc actually consumed was not more than 10 per cent. in excess of the theoretical amount. The Weymersch battery, some details of which we give below, is now being manufactured by the India Rubber, Gutta Percha and Telegraph Works Company of Silvertown.

The standard size consists of a rectangular trough of ebonite, 9½in. by 11in. by 13 75in., divided into six cells by means of ebonite partitions. In each cell is fixed securely a porous pot having a capacity of about one quart, and fitted with a short ebonite pipe. All these pipes are connected to a common pipe, also of ebonite, and provided with an ebonite tap and a gauge glass. It will be seen that by this means all the porous pots are connected together, and can be quickly and easily emptied by merely opening the tap. In a like manner all the outside cells are connected together and fitted with a tap for emptying. The general arrangement has been made with a view to reducing the time required for charging and discharging to a minimum, and permits of either operation being performed in a few minutes without the usual disagreeable labour. Two stoneware barrels, fitted with stoneware taps, are placed on a shelf above the battery level, and connected with the cells by means of suitable lengths of india-rubber tubing One of the barrels is fitted with the exciting liquid, and the other with the new depolariser. When it is required to charge the battery, the india-rubber tubes are fixed upon the mouths of the proper battery taps, and the solutions allowed to flow until they rise to the point indicated on the levels at the end of the battery trough; the battery is now ready for immediate work. When it is required to empty the battery it is only necessary to open the taps and allow the spent solution to flow away. Two zinc plates are placed in each outside cell, one on each side of the porous pot which contains the negative element, carbon and the new depolariser. The carbon heads are well coppered and securely clamped by a tinned brass clamp, into which solder is run, making a perfect and lasting contact, and doing away with the constant trouble usually given by carbon contacts. The carbons and zincs are carried on a wooden slab which has been well boiled in paraffin wax, and which forms the battery lid; the connecting strips are of stout brass well tinned. The zincs are sent out by the makers specially amalgamated, and if the current is not allowed to exceed the maximum for which the battery is designed, they will not require re-amalgamating, the first amalgamation lasting as long as the zincs.

The E.M.F. of the standard battery on open circuit, the dimensions of which have already been given, is 13 volts for the six cells. It is designed to give a current of 15 amperes for about seven hours continuously. The total charge of depolarising solution for the six cells is 11 pints, and the total energy given out is about 1,300 watt-hours, of which between 750 and 800 watt-hours are expended in the external circuit, or say 230 watt-hours per quart of solution. The current remains nearly constant during the first seven hours after charging, rising slowly for the first two hours, and after remaining constant for three or four hours, slowly falling for the rest of the time, so that at the end of the run the current is about the

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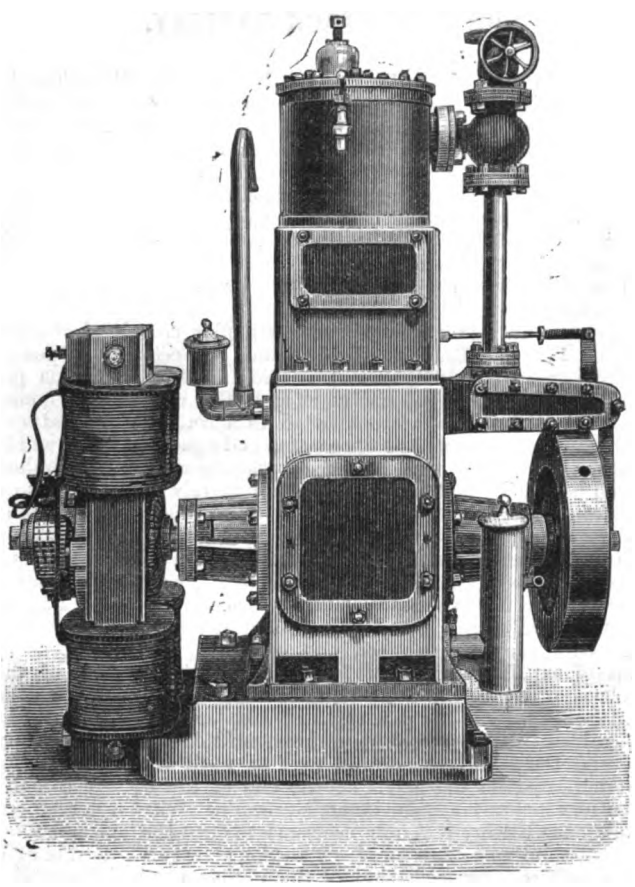
same as at starting. This rise and fall, however, is very small. If after the first seven hours' work the current be reduced to 10 amperes, a further constant run giving about 400 watt-hours may be obtained, thus giving a total energy per quart of depolariser of about 305 watt-hours. Two of the standard size batteries will run 10 8 candle-power or 16 5 candle-power incandescent lamps for seven hours, and, as indicated above, if the number of lamps is reduced at the end of this time, a further run of three or four hours can be obtained.

For transport the depolariser is supplied in the form of salts, which require the addition of water only in order to obtain the solution. The exciting liquid is a solution of sulphuric acid and water in the proportion of 1 of acid to 18 of water.

This battery, it will be thus seen, is very suitable for small installations where facilities exist for handling acids or for light motor work in situations where it would be inconvenient to use power derived from a dynamo machine.

THE CHANDLER HIGH-SPEED ENGINE.

Since their first introduction a few years back, the Chandler "silent" high-speed engines have proved themselves specially



The Chandler High-Speed Engine and Crompton Dynamo.

suited for use on board ship, where their compactness, reliability, and absence of noise renders them invaluable. The excellent results which have been obtained with these single-acting engines are doubtless due as much as anything to high-class workmanship and the very perfect method of lubrication adopted. Crank-shafts, connecting rods, &c., are all of steel, and the bearings, which are of great length and diameter, are of phosphor-bronze, and work in a bath of oil.

The above block shows one of these engines combined with a Crompton dynamo. This arrangement, as will be seen, is of a very compact description. No outside bearing is required for the dynamo, as the armature is close up to the bearing of the engine, and the crank shaft being exceptionally strong, and a long bearing being used, the armature simply acts as a small flywheel. The dynamo runs at 600 revolutions, and is capable of supplying fifty 16 candle-power lamps.

These engines, for which there is at the present moment a very large demand, are made by Mr. F. D. Bumsted, of Hednesford.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June* 15, 1889.

There are further interesting developments this week with regard to the ticker trouble about which I wrote you extensively in my last letter. The movement of the Stock Exchange against the bucket shops by cutting off the ticker service was soon seen to be a failure, and hence there was nothing for the Stock Exchange to do but to resume the use of the tickers, as it very sensibly did after a brief intermission. But the stock-brokers now find support and encouragement from quite another quarter. At the last meeting of the New York Legislature a Bill was passed for the purpose of putting down the bucket shops. The object of the Bill was to declare guilty of a misdemeanour any person who should "keep a room to be used for making wagers or bets upon any lot, chance, casualty, unknown or contingent event, or on the future price of stocks, bonds, securities, commodities, or property of any description whatever, or for making any contract for or on account of any money, property or thing in action so bet or wagered." The Governor has now reached this Bill, and has attached his signature to it, rendering it valid, instead of rejecting it as he might have done. He says that he thinks it is an honest Bill and one which should therefore become law. He is convinced, he says, that it will not injuriously affect or prohibit any transaction or business which rightfully or morally is entitled to protection, while it will put down what is regarded by some people as respectable gambling. This is quite a heavy blow, but having survived the deprivation of their ticker service, it is possible that the bucket shops may live through even this ordeal. They are running in full blast, and some of them have issued an announcement to their customers to the effect that their business will not be affected by the Bill in any way, and that they will receive and execute orders "with the same understanding hereafter as before, actual deliveries being in all cases contemplated and understood." In some quarters it is said that Governor Hill would not have signed this Bill if he did not believe that it is practically to be inoperative. The fact is that it will probably remain a dead letter unless the Stock Exchange itself makes a business of seeing to its enforcement, and then, perhaps, some good may come of it. There can be no question as to the great harm done by the bucket shops in encouraging gambling and dishonesty amongst messenger boys and poor young clerks, but it very often puzzles ordinary folk to understand just where the line is drawn between the ethics that apply to bucket-shop practice and those which govern transactions on the Stock Exchange. I confess I am not casuist enough to draw the line myself.

The matter of electrical executions is commanding a large share of public attention just now, an appeal having been made on behalf of Kemmler, the murderer awaiting electrical execution at Auburn prison in this State. The execution has been postponed, and it begins to look as though it might not take place after all. Further steps have been taken bringing the matter before the General Term in order to review and test the constitutionality of the electrical law. The application for *habeas corpus* alleges that, contrary to the Constitution of the State and of the United States, Kemmler has been sentenced to undergo a "cruel and unusual" punishment, and there seems good reason to believe that the court may hold the use of electricity to be within such a construction. The case will be argued on June 18. In the meantime the newspapers have been canvassing electrical opinion all over the country, and it must be said that as far as they have succeeded in eliciting views on the subject they show the general sentiment to run very strongly against the use of electricity for capital punishment. Dr. Vander Weyde offers the suggestion that instead of using electricity, which is uncertain in its results on the human system, it would be a good thing to substitute suffocation by illuminating gas, which is well known to be perfectly successful in killing people. Back of the general feeling against the use of electricity at all is another feeling that the opportunity has been seized for business

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and commercial reasons to bring the alternating current into disrepute and to attach suspicion to the Westinghouse system. So far has the discussion on this particular point gone, that one of the leading lawyers, in taking up the case for Kemmler, seizes the occasion to state that he is not retained by the Westinghouse Company. The general feeling among electricians is that if it were actually wanted to kill the criminal outright it would be easy enough to do it by taking an arc current of 3,000 or 4,000 volts and applying it direct, whereas it is proposed instead to use the alternating current down to as low a voltage as may be possible and thus show that the alternating current is not a safe thing to use for general purposes. Of course, the use of a current of higher electro-motive force would be likely to result in horrible mutilation of the body, and in other disagreeable features, but even then there would be considerable uncertainty in any given case. Altogether it may be said that American electricians are not a little tired and disgusted over the matter, especially as two or three other States are proposing to follow New York's example in the matter. Massachusetts, for example, is just falling into line, and a Bill is now before the Senate Judiciary Committee there, allowing the death sentence to be carried out by electrical means.

The New York Legislature has authorised the expenditure of $3,000,000 for the repairing and paving of the streets of this city, and a great many people are asking what will be the good of spending all this money when the streets will be ripped up again almost as soon as they are put down? The condition of the New York streets, in fact, tends from bad to worse, not because the money is not forthcoming to keep them in order, nor because the work is badly done, but for the reason that the stones are no sooner down than they are up again. If the road paving is not disturbed by the Gas Company, the Steam-Heating Company is likely to supply the omission, and if both these parties fail the Subway people are sure to come along and turn things topsy-turvy. If all these should fail, something is found to be the matter with the water pipes. Thus it happens that from the beginning of the year to the end, and even when frost renders the ground as hard as a rock, some of the streets are broken up, and present the appearance of barricaded French thoroughfares, with piles of earth and stone breast high. Some idea of the extent to which the streets are ripped up may be formed from the fact that during the last six months of 1888 the Steam-Heating Company alone made 240 excavations for purposes of repair and 28 for service connections. This alone would be enough to ruin the finest paving in the world. Now that there is talk of an extension of the subway system, and that $3,000,000 is to be spent on repairing the paving and streets, there is also a very general feeling that the subways ought to be built before the work begins, or else that it would be better to get along without them. This situation with regard to the subways gives an interest at this time to the bids which the electric light companies are making for the city lighting. The local companies have decided to make a difference in their bids for districts where there are subways and those where there are not. They propose to charge 65 cents where subways exist, and 35 cents elsewhere, and they have tendered at this rate. The Gas Commission, however, has rejected the bids of the six companies, and now bids will be advertised for with the idea, it is said, of breaking up the "combine" which the companies have made. Major Grant is understood to be very much put out because the Grand Jury has declined to indict the electric light companies for assumed violations of his edict, and perhaps, as he is a member of the Gas Commission, this is one of his ways of getting even. Everybody knows that it is considerably more costly for the companies to supply light through wires in the conduits than it is by means of overhead wires, and it is only to be expected that they would have different rates for the different class of work.

Some interesting trials have been made this week of the improved Sims-Edison torpedo at Willet's Point, near this city. The torpedo in question was approved and adopted by the Government some time ago, but certain improvements were deemed necessary, and it would appear that they have now been introduced. This torpedo is governed and operated from *terra firma*, or a ship if desired. It carries a small motor, and is connected with the shore by means of a very light conductor, through which current travels from a dynamo. By means of this current the vessel is not only propelled but steered in any desired direction. In the tests which have been made this week, the torpedo used was 31ft. long and 28in. in diameter, weighing 3,000 pounds. The speed attained was at the rate of about 21 miles an hour in a run of over 800ft., current being supplied at the rate, it is said, of 25 amperes and 900 volts, the 30in. screw making about 900 revolutions per minute. This torpedo, the electrical attachments for which have been studied out by Mr. Edison and built at the Edison machine works, is very easily manipulated and manœuvred, and can not only be steered at any angle, but can be made to dive under any obstruction met when running. In view of the fact that we have so few men-of-war, and yet have so large a coast to defend, it is thought extremely probable that the torpedo service will have to be one of our chief arms of marine warfare.

There is every prospect that the electrical welding business based on the process invented and elaborated by Prof. Elihu Thomson will develop into quite a large department of industry. The Thomson Electric Welding Company, although they have but just begun business, are already enlarging their factory at Lynn, having work on hand for several months to come. They have recently been given an order from the Trenton Iron Company for machines to weld steel wire-cable. The tests on welded specimens of this cable which were made at one of the United States arsenals show an efficiency of 82 per cent. of the tensile strength of the original cable. Another application for the apparatus that I heard of this week is its use in a new barrel factory at Worcester, Mass., where the hoops for the barrels are made out of steel wire welded. It is said that this method is at once economical and effective.

Telegraphic history in this country includes the careers of a great many men who have risen from the ranks and become leaders in the service; in fact, there are very few men at the head of telegraphic affairs here who have not begun life as telegraph messenger-boys or as operators. These numerous instances of promotion are a good exemplification of the fact that in this country Napoleon's aphorism, that a career is always open to talent, is better justified than under any of the conditions which prevail in the Old World. But for examples of telegraph messengers and operators who have risen in the world we need not look to the ranks of telegraphy alone; we may find them in almost every branch of the electrical profession. A great many of them, again, on leaving the telegraphic field have attained distinction in a variety of occupations, and some of them are to-day among the best-known men in the country. In this last class I may mention such a notability as Andrew Carnegie, who got his first overcoat while a poor little messenger-boy in Pittsburgh, and who to-day by his well-considered and frequent benefactions on the largest scale is setting a splendid example to other rich men of the wise employment of wealth. Mr. Carnegie's rise in the world is recalled by the fact that another Pittsburgh telegraph boy has made his mark. Last week President Harrison appointed Mr Arthur L. Thomas to be Governor of the territory of Utah. Only as recently as 1869 young Thomas was engaged in Pittsburgh in distributing the press reports to each paper. At that time he was wont to amuse the operators in the lunch hour by telling them of his ambition to follow Horace Greeley's advice by going West and growing up with the country, so that he might come back to Washington as a Congressman. Just about that time a local politician was elected to Congress after a hard fight, in which he received the support of the Welsh element. Desiring to return the favour in some degree, he asked his Welsh constituents to pick out somebody that he might secure a position for at Washington. The choice fell upon the messenger boy, and he was given a clerical appointment in the House of Representatives. There his intelligence and willingness made him many friends among the senators and representatives, and he remained in the office until he was made Secretary for Utah by President Garfield. He then became a member of the Election Commission of the territory, and now becomes its Governor. Thus at the age of 34 he reaches one of the highest positions of the

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country, with a prospect of the attainment of even greater honours.

As you were always among those who regarded the speculative development of the electric sugar-refining process with suspicion, and were foremost in predicting the ultimate exposure of the fraud, you will be interested to know that the disclosures which were made a month or two ago when the stock of the concern went down to zero have been followed up by even more absurd and startling revelations in the case which has been brought by the State against the late Prof. Friend's confederates. It will be remembered that Prof. Friend was willing to have submitted to him the worst possible trash in the shape of raw sugar for manipulation, and that no matter how bad its condition, after it had gone through his secret treatment, it came out as good as could be obtained in the market. The purity of the sugar was certainly wonderful, but it need no longer be marvelled at, because this week witnesses have been on the stand who have proved the sale to the defendant of "quantities of mould A" sugar, the purest refined made by Havemeyer and Elder. Another interesting little fact is that the dates of the sales coincide with the dates of the various extraordinary "runs" of electric sugar, and the quantities are almost identical with those turned out to the bewilderment of the investors in the stock. Other witnesses have been on the stand who testified to smashing the refined sugar with hammers, while others gave evidence as to getting it ready for the famous "runs" from the roof to the cellar. After this I do not think anybody will be likely to express any more faith in this big swindle. The joke of the whole matter is that the well-meant advice of electricians to the fools who were determined to put their money into the swindle was treated with the utmost scorn and contempt, and that Prof. Friend was outspoken in his hostility to electric experts. He would have none of them. In this respect, however, he was not singular. I heard of a case the other day in which a bright young electrical engineer sought to obtain employment from one of the newest storage battery companies. Thinking to recommend himself by a statement of how much he knew and could do, he naturally began to enumerate his qualifications and to enlarge on his experience. Much to his surprise, however, the gentleman who calls himself the electrician of the company told him that he did not want to have any such man about him. What he wanted was men who did not know anything. When I add that the person who made this remark is responsible for building storage batteries of a shape that long since became obsolete, it will readily be understood that he is capable of just such an utterance. The only pity is that a man of such calibre should enjoy the confidence of capitalists and be entrusted with the electrical work of what might be a large concern. The young fellow that I speak of was of course greatly annoyed and chagrined by the incident, and now is somewhat in doubt as to what capacity he shall appear in when he next applies for a position.

CORRESPONDENCE.

RECENT GAS BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your last issue of the 21st you mention a gas battery devised by Mr. Ludwig Mond and Dr. Carl Langer, and which evidently is much the same as some made and described by me in the *English Mechanic*, Nos. 1,245, 1,246, 1,249, 1,252, 1,253, 1,255, 1,257, in this year's issue, and as I lay claim to being the first to use either pierced or wire-mesh plates covered with platinum black, and the method of passing air over or through the plate in order to evaporate the surplus water and to generate ozone in the plate, I should feel much obliged if you would publish this, for this method has been known and practised by me for the last two years, as my letters to the *English Mechanic* will show.

The discussion on gas batteries in the above paper, from No. 1,243 to No. 1,257, might prove interesting to some of your readers. Also I must say I consider, with all due deference to the constructors of the battery mentioned by you, that the result obtained is a very poor return from a plate-area of 120 inches square, for, as far as I can understand from your report, its action merely depends on the occlusion of gas in the plate itself, the supply of gas being intermittent, whereas the action of a gas battery ought to depend not on the inherent property of a certain metal or substance to occlude gas, but on the intermolecular porosity of the plate itself—granted that intermolecular action is that property which allows of the passing of a gas or liquid through any substance which gas or liquid is condensed in or among the particles of the substance in passing through, and remains inert in that condition until called for, *i.e.*, on the closing of the circuit; and this property, as I have explained in the above-mentioned letters, is increased by the subdivision of the substance itself, and the less the intermolecular porosity the greater the pressure of gas required, the greater the intermolecular porosity the less pressure required, except so far as to overcome the capillary attraction of the acid to the plate; if this capillary attraction is destroyed, the gas will pass through the plate at any point above the pressure of acid it is required to sustain—that is, height of cell.

Apologising for the length of this letter, which I cannot help asking you to publish in justice to myself—Yours, &c,

ALFRED TREEBY.

BOROUGH OF BRADFORD: PROPOSED BYE-LAWS IN CONNECTION WITH THE CORPORATION SUPPLY OF ELECTRICITY.

The Board of Trade, in pursuance of the power vested in them in that behalf, hereby make and ordain the following bye-laws for the better ensuring safety in the supply of electricity by the Mayor, Aldermen and burgesses of the said borough, hereafter called the Corporation, pursuant to the provisions of the Electric Lighting Act, 1882, and the Act of 46 and 47 Vic., cap. 220, confirming the Bradford Provisional Order for such supply of electricity; that is to say:—

Rules for wiring of Houses. 1. All wiring, fittings, apparatus, and other appliances, must be supplied and fixed in accordance with the "Rules and Regulations of the Society of Telegraph Engineers and Electricians" (April, 1888), and of any other regulations which the Corporation may require.

Conductors. 2. The sectional area of all conductors shall be so proportioned that the maximum current conveyed in any conductor shall not exceed the ratio of 1,000 amperes per square inch of section of copper conductor.

No portion of the metal work of any brackets, electroliers, or other electrical fittings, or of any gas or water pipe, is to be used as part of the electrical metallic circuit as "earths" might readily be formed by any such connections.

Insulation Resistance of Installation. 3. The insulation resistance of the entire installation (when all the mains, wires, fittings, lamps, motors, and other appliances are fixed) shall not, as proved to the satisfaction of the Corporation, be less than the total number of ohms which shall be indicated by the number resulting from the division of 10,000,000 by the number expressing the maximum electric current in amperes which has been named by the consumer in his application for his supply of electricity.

In the event of the insulation at any time falling below the above standard, and continuing so, the Corporation may, after due notice, discontinue the supply of electricity to the premises.

Unauthorised Extensions. Penalty attached to. 4. Should it be found that any consumer is using a current in excess of the maximum with which he has required the Undertakers to supply him, without notice having been given in accordance with the Act, the Corporation may, if they think fit, discontinue the electric supply to this consumer until they have made proper provision for such increase.

"Earths." 5. All connections direct with "earth," or connections tending to cause "earth," such as with gas or water pipes or other metallic bodies are absolutely forbidden, without the express sanction in writing of the Corporation.

Penalty attached thereto. 6. Should any such "earths" be at any time found to exist in an installation, whether through an intentionally made connection or by neglect of any of the prescribed regulations as to wiring or as to fittings, or from any other cause, the Corporation, if they deem it necessary or advisable, may discontinue, even without notice, the supply of electricity to the installation until such "earths" or other defect has been made good by the consumer to the entire satisfaction of the Corporation, and so notified in writing.

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Dead ends, &c., to be sealed up. 7. All dead ends which may occur in the installation should have their extremities carefully sealed up, so as to avoid all chance of "earths" being formed therefrom.

Notice as to leaks. 8. Should any leak, or "earth," or other serious defect be discovered by the consumer, either within the installation itself, or in its immediate vicinity outside the premises, he is bound at once and without delay to give notice thereof to the Corporation or their Electrical Engineer, so that the defect may be at once properly remedied.

Main disconnecting switches. 9. Two switches, one on each main respectively shall be fixed, in a readily accessible position, on the two mains leading from the meter to the premises, at a point immediately adjacent to the meter, if possible, and subject to the approval of the Corporation or their Electrical Engineer. These switches must be so arranged that the entire of the current passing into the installation can be, when necessary, cut off by them.

Access to main switches by Corporation officials. 10. The proper officers of the Corporation shall have the right of access at all times to these switches.

Alterations, repairs, &c., notice of. 11. In the event of any alterations, repairs, extensions, or other interference, from whatever cause, with the ordinary working of the installation, notice must be given to the Corporation or their Electrical Engineer at least twenty-four hours before such alterations or other operations commence, and indicating the time at which it is intended to commence such operations.

Current to be cut-off during alterations, repairs, &c. 12. During the entire time, whether continuously or with interruptions, that such alterations or other operations are in course of execution, the electric supply from the outside must be entirely disconnected from the premises by means of both of the above-named main disconnecting switches. Any exception to this regulation must have the express sanction in writing of the Corporation or their Electrical Engineer.

Interruptions by Corporation during alterations, repairs, &c. 13. In the event of the electric supply not being properly and efficiently cut off from the premises whilst such alterations, repairs, or other operations are being carried on, the officers of the Corporation may, if they deem it necessary, even without notice, completely interrupt the electric supply to the premises, in any way which they think advisable.

Disturbance of streets, &c., in vicinity of electrical cables, &c. 14. Whenever any disturbance or other interference may be required or contemplated, with the surface or other parts of any street, causeway, pavement, or any other place in the vicinity of any electrical cables, wires, or other apparatus or matter connected with the public supply of electricity, the person or body charged with carrying out the above-named disturbance, or interference with such street, or other places, shall give notice in writing of such intention to the Corporation.

15. Such notice should, where possible, be delivered at least twenty-four hours before the commencement of such intended disturbance or other interference.

Notice to the Electrical Engineer's office. 16. The notice should also designate the locality of such intended disturbance, &c., as also the time at which such operations are proposed to be commenced, so as to allow of the attendance at such locality of an official from the Electrical Engineer, in order to point out the exact position of the electrical cables, wires, and other apparatus, and also that he may take any steps required for the proper protection thereof.

Penalty. 17. Any person offending against or not complying with any of the above regulations shall be liable to a penalty not exceeding £5, and a daily recurring penalty not exceeding such sum so long as the offence or neglect may continue.

Electrical Engineer. 18. In the above bye-laws, the term Electrical Engineer shall mean the person whom the Corporation may from time to time appoint to take charge of their electrical works.

Office. 19. The Corporation shall appoint an office in the Town Hall, where all notices may be served in connection with the above bye-laws.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

June 8, 1889.

9,537. J. A. Timmis. London. Improvements in incandescent electric lamps.

9,541. F. Lindley. London. Improvements in appliances for attaching telegraph and other wires to insulators and similar uses.

9,571. J. E. Kingsbury. London. Arrangement of circuits and apparatus to be used in connection with telephonic communication (F. R. Welles, Belgium).

9,576. H. H. Lake. London. Improvements in and relating to incandescent electric lamps (S. F. Van Choate, United States).

June 11, 1889.

9,589. J. C. Ricketson. London. Improvements in electric signals for indicating the direction and speed of revolution of engine shaft

9,638. E. S. Drake. London. Improvements in telephonic and phonographic transmitters.

9,659. A. H. Norman. London. Improvements in and connected with electric batteries.

June 12, 1889.

9,667. G. Wilkinson. London. Improvements in apparatus for the generation of electricity.

9,681. R. Tatham. Liverpool. Improvements in electrical storage or secondary batteries.

9,713. J. G. Lorrain. Strand. Improvements in electric conductors (La Société d'Exploitation des Cables Electriques Système Berthoud, Borel et Cie., Switzerland).

9,723. The Electrical Power Storage Company and P. J. Rea. London. Improvements in grids or containers for the elements or plates of secondary batteries and moulds to be used in their manufacture.

SPECIFICATIONS PUBLISHED.

1888.

8,525. Rawson and John. Electric trembling bells. (Price 8d.)

10,092. Lineff. Supplying electricity to tramcars, &c. (Price 11d.)

10,299. Wallace (Scott). Electric logs. (Price 8d.)

10,654. Mortimer and Holloway. Electric arc lamps. (Price 8d.)

10,929. Cox-Walker and Swinton. Magneto-electric generators, &c. (Price 8d.)

THE SCOTTISH ELECTRIC SUPPLY COMPANY (LIMITED).

We have received the prospectus of this Company, which has a capital of £100,000, in 10,000 shares of £10 each, with power to increase. The present issue is 2,500 shares of £10 each.

The following constitute the influential Board of Directors :—

G. F. Armstrong, C.E., Regius Professor of Engineering in the University of Edinburgh.

W. Allan Carter, M Inst.C.E., 5, St. Andrew-square, Edinburgh.

John Henry Davidson, Merchant, 133, Princes-street, Edinburgh.

Wm. Geipel, M.Inst.E.E., and Lecturer on Electrical Engineering in the Heriot-Watt College, 19, Great King-street, Edinburgh.

Alex. Low, of Laws, Advocate, 12, Drumsheugh-gardens, Edinburgh.

Charles Ritchie, S.S.C., 20, Hill-street, Edinburgh.

Lieut.-Colonel G. Mure Steel, 4, Atholl-crescent, Edinburgh.

The consulting engineer is Mr. Alan A. Campbell Swinton, Assoc.Inst.E.E., of 66, Victoria-street, London, S.W.; the secretaries are Messrs. Brewis and Rainie, C.A., and the offices are situate at 5, North St. David-street, Edinburgh.

In the prospectus the directors state that they believe the work of electric lighting and the supply of electric power in Edinburgh and surrounding district (combined, if necessary, with the other business referred to in the Memorandum of Association) can be established on a sound and scientific basis and at a profit to shareholders. They have carefully considered reports furnished by experts, and estimates of cost, and have made arrangements for ground suitable for a central station at Lochrin, adjoining the Union Canal, where there is ample room for extension, and where coal can be obtained at the lowest cost. When expedient the directors intend to apply for a Provisional Order under the Electric Lighting Act of 1888. No promotion-money has been or will be paid.

[The Lists of Application will close on or before to-morrow (Saturday).]

COMPANIES' MEETINGS & REPORTS.

South of England Telephone Company (Limited).

The sixth ordinary general meeting of the shareholders of this Company was held yesterday at Winchester House, Old Broad-street, Mr. D. Owen Bateson presiding.

The SECRETARY (Mr. Fred. L. Robinson) having read the notice calling the meeting,

The CHAIRMAN said: Since our last annual meeting we have lost one of our number. Mr. Campbell was one of our original Directors, and while his health lasted was most regular in his attendance at our Board meetings. His services were much valued by us, as he brought to our consultations an amount of good sense and great business aptitude, which we highly appreciated. His departure from among us was, I assure you, deeply deplored. Mr. Charles Billete was elected to the vacant chair, and from our experience of his services since his election I am quite convinced we have made no mistake in his appointment. The figures we have laid before you in our balance-sheet show the progress of the Company during the past financial year; they are sufficiently full, so they require very little explanation on my part. It will be noted that our expenditure on capital account is £19,917. 12s. 6d.; this exceeds last year by £3,460. 5s. 9d., which is accounted for by the increase of business in a great measure, viz., 451 exchange and 114 private lines, and I think ought to be satisfactory to the shareholders, as it results in a substantial increase in our gross rentals. Another matter tending towards increased expenditure has been the rise in the value of copper wire; this, however, is now over, at all events for the present, and we are obtaining our supplies of this article at

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much more moderate prices than have been current during the past twelve months. Again, we have spent a good deal of money on trunk lines in our district, joining up the several towns in which we have exchanges, and gradually connecting them together, so that when the good time comes which we have been so long expecting when we shall be admitted into London, only short lengths will be required to enable us to join hands to the Metropolitan system. The revenue, £18,792. 15s. 3d., shows an increase of rentals over last year of £4,928. 5s. 4d., but we are obliged to transfer £9,041. 8s. 11d., which is an increase of £2,070. 12s. 11d., to the present year; the great activity in our business being in the summer, the unearned increment consequently is proportionately large. This sum, however, will be for disposal during the year we have just entered on. You will note the large sum we have paid for royalties, £3,455. 3s. 7d. This is a very heavy tax on our resources, really amounting to 7 per cent. on our paid-up capital. With respect to this item of royalties, I notice in a very able letter from the United Company to the Secretary of the Post Office, they "suggest that the public would be better served if the heavy tax imposed by the Post Office upon telephonic communication were removed." Upon this I would venture to suggest that it would be an additional service to the public were the large royalties levied by the United Company on the subsidiary companies abolished, or at least materially modified. Were this done it might strengthen the hands of the United Company in any negotiation with the Post Office, and be certainly a good example for the department to follow. I am glad to say that since we last met we have obtained from the Stock Exchange a quotation on the market; this, I take it, will be of considerable service to us, as it makes our shares a much more marketable security than formerly. Both Ordinary and Preference shares are now quoted. You will note from the report that the long standing dispute with the United Company has been settled, and the invidious memorandum inserted by the auditors in our former balance-sheets, had been eliminated this year. We succeeded in reducing the claim from £1,845 to £1,264. This I think is sufficient justification for your directors in resisting what they considered an unfair demand. The whole of the payment has been carried to the debit of revenue with the exception of £148. 16s. 8d., the unexpired rent of the Brighton trunk wire, and of course goes to the reduction of our net profits this year. The year's proportion of preliminary expenses, £373. 19s. 7d., has been charged to revenue. The balance of this account will entirely disappear in our next balance-sheet. I am sorry to say that we have made no progress towards connecting our district with the Metropolitan system. The demand for trunk lines for this purpose from our subscribers continues, but as yet the United Company have not seen fit to grant any facilities in this direction, though we have constantly urged the matter on their attention. I understand they are running lines through our district, as under our agreement they have undoubtedly the power, with the intention of connecting up Birmingham in one direction and Bristol in another, but why they are willing to grant accommodation to these distant towns, and refuse it to places contiguous to their own centre, and to parties, many of whom are already subscribers to the London Exchange, is a matter I cannot understand. The lines I allude to pass through our district, and we have reason to complain that they are being run without any consultation with us as to the route they should take, so as to interfere as little as possible with our way-leave arrangements, which year by year are becoming more difficult to manage, and we think it would have been a matter of only ordinary courtesy had our views been asked before the lines were decided on. I really think that a little more regard might have been paid to the convenience of a Company to which they have assigned a district and in whose success they have so large an interest both as regards royalties and dividends. I hope the new management, as I expect there will be new management, will put such matters as this on a better footing in future. There is another thing I wish to allude to before I finish and that is our relations with the Post Office. I notice there has been a good deal said and some hard words used with reference to the treatment experienced by other companies from this department of the public service. I can only say as regards the South of England Company, that they have always received the greatest courtesy at the hands of the department. We know very well the terms upon which we hold the license, and though its terms are onerous enough, we have never tried to go behind or beyond its requirements. We have in no instance asked anything that has not been granted by them, and on our part as the terms of the license are sufficiently clear we can easily calculate the approximate amount of our royalties, and having done this a cheque for the amount is forwarded without delay. I named this matter in justice to a public office from which we have always received the utmost consideration, and with which we have always worked without the slightest friction. The dividend we propose to pay on the Ordinary shares of the Company (the distribution of 6 per cent. per annum on the Preferences having already been made, and they amount to nearly £1,000 more than last year), is 1 per cent. This is ½ per cent. more than last year, and I hope it will be approved of by the shareholders. The balance, £627. 1s. 2d., we intend to carry forward to this year. There is nothing more that I need say on the subject, but I should be very glad to answer any questions that may be asked. I beg to propose

"*That the report and accounts for the year ended 30th April, 1889, now presented be adopted and passed.*"

Mr. ALEXANDER MACGREGOR seconded the motion, which was unanimously adopted.

The CHAIRMAN next moved:—

"*That a dividend at the rate of 1 per cent., free of income-tax, on the Ordinary Shares be now declared, payable on the 28th June.*"

Mr. CHARLES BILLETT seconded the resolution, which was carried.

Mr. DELF asked whether Northampton was to be connected with London, and whether there was any chance of the Company being amalgamated with the United Company. He thought that by amalgamating both Companies would be strengthened.

The CHAIRMAN: I quite agree that unity is strength, but up to the present the matter lies entirely in the hands of the United Company, and we have not yet been approached upon the subject, therefore we do not know what is passing. You know quite as much as the Directors do. As regards the Northampton line the United Company are proposing to run a line between London and Birmingham, but so far as I know nothing has been done with the line from Northampton to London.

On the motion of the CHAIRMAN, seconded by Mr. ROBERTS, the retiring Director, Mr. Alexander MacGregor, was re-elected to his seat at the Board.

On the motion of Mr. PONSFORD, seconded by Mr. ROBERTS, the following resolution was unanimously agreed to:—

"*That the sum of £200 be paid to the Directors for their services during the year ended 30th April, 1889.*"

Mr. BISHOP proposed and Mr. ROBERTS seconded—

"*That Mr. John Weise, of Messrs. Turquand, Youngs and Co., be re-elected Auditor for the present year, with a remuneration of 40 guineas.*"

The proceedings then terminated.

Manchester Edison-Swan Company (Limited).

The annual meeting of the shareholders of this Company was held on Tuesday last at the Memorial Hall, Manchester, Mr. Vernon K. Armitage in the chair.

The following report of the Directors, for the year ending 31st May, which had previously been circulated amongst the shareholders, was taken as read:—

The Directors beg to submit the accompanying balance-sheet. The net profit, including last year's balance, amounts to £2,754. 11s. 7d., which it is proposed to appropriate as follows:—To payment of dividend at 5 per cent. per annum, £1,000; to reserve fund, £1,000; balance, £754. 11s. 7d.—total,

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SILICIUM BRONZE AND SILICIUM COPPER WIRE.
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AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
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PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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£2,754. 11s. 7d. If the above be approved the dividend warrants will be issued on the 5th July, 1889. During the past year there has been a considerable increase in the business done by the Company, not only in the United Kingdom, but also abroad. The satisfactory working of the numerous electric lighting plants installed, and the growing demand for both arc and incandescent lighting afford great encouragement for the future. The negotiations with the Manchester Corporation for the establishment of a central station in the city have been continued, but as yet without any definite result. The Company have given the Corporation formal notice of their intention to apply to the Board of Trade for a Provisional Order, and in the meantime have asked their assent to an application for a License. Hitherto the Directors have refrained from asking any remuneration for their services, but they consider the time has now arrived when this matter may properly be dealt with. In accordance with the Company's articles of association, the Chairman, Mr. Vernon Kirk Armitage, retires from the Board. He is, however, eligible, and offers himself for re-election.

The CHAIRMAN said that he thought they would agree with him that they had reason to congratulate themselves on the result of the year's work. Their confidence that prosperity would come some day or another to the Company was now in process of being justified. He attributed a very large share of the prosperity the Company was enjoying and seemed about to enjoy to the very excellent work of their managing director, Mr. Williamson. As showing the increased demand for the light which was referred to in the report, he might say that they had installed nearly 7,000 lamps in the course of the year, and that they had sent out estimates for some 30,000—a considerably larger percentage of installations in proportion to estimates sent out than they had in former years. The most satisfactory item in the balance-sheet was that whereas last year there was only some £1,700 of profit to dispose of, this year they had £2,700. He might further say that since the 31st of May of this year they had obtained orders to the amount of nearly £5,000. With regard to the negotiations with the Manchester Corporation, it would be remembered that at the extraordinary general meeting of the Company held recently the Directors informed the shareholders that the Manchester Corporation seemed to be holding their hands and waiting for some evidence of the wish of the public for the establishment of electric lighting stations in Manchester, and the first thing that was done, after the shareholders' consent had been given to the resolution proposed at that meeting, was to issue a circular enclosing a postcard asking the recipients to state if they would be willing to take the electric light in case it were installed in the centre of Manchester. The Directors only contemplated the establishment of a central station for 10,000 lights, but they obtained in the course of three or four weeks postcards filled up by people who were prepared to take something like 14,500 lights. With that information in their hands they approached the Manchester Corporation again, and he must say he was disappointed that no further advance had been made. It was true the Corporation had appointed a committee to deal with the whole question, but what that committee had done, or whether it had done anything, he was not in a position to say. As it might be eighteen months before the Company got the Provisional Order for which they had applied, and of which application they had given notice to the Corporation, they had asked the Corporation to assent to an application they had made for a Provisional License, by obtaining which they would be able to set to work within a much shorter time than eighteen months. They had only received in reply an intimation that the committee would take the matter into consideration. How long the consideration of the matter would take, or whether it would throw them back another year with their application to the Board of Trade he did not know. All he could say was that they would do their best to urge on the Corporation the importance of their ceasing to occupy a merely obstructive position in connection with so important a subject as electric lighting. With regard to the shares of the Company, he was glad to say that they had recovered from the position in which they were placed by the foolish action of one of the shareholders at the last meeting, and unless there were more foolish shareholders who were prepared to sacrifice their property, he did not believe they were likely to have a recurrence of such a state of things as that which followed the last meeting. He moved that the report be approved and adopted.

Sir J. C. LEE seconded the motion, which was carried.

Mr. GRIMSHAW asked whether the Directors had any definite information as to the intentions of the Corporation?

The CHAIRMAN: None whatever.

Mr. GRIMSHAW said he had been told by an alderman that the Corporation intended to apply for a license themselves, and to take the whole thing in their own hands.

The CHAIRMAN said there could be no doubt that the Corporation did prepare a Provisional Order some six or eight years ago, but it had never got out of the municipal offices. The Corporation, of course, could not use the Edison-Swan Company's patents. Whatever they did they would have to go to somebody, and whoever did the work the Edison-Swan Company would no doubt come in for a considerable share of it.

The CHAIRMAN moved, and Mr. EDWARD CROSS seconded, a motion in favour of the division of the profits, as recommended in the report, but this motion was afterwards withdrawn in favour of one by Mr. CHARLES AGNEW, seconded by Mr. RICHARD WHEELDON, to the effect that the profits be divided as recommended, except that the sum of £300 be divided amongst the Directors for their services during the year. Mr. Agnew spoke in high praise of the Directors' services to the Company.

The motion was adopted.

On the motion of Mr. AGNEW, seconded by Mr. J. F. FISHER, Mr. V. K. Armitage was re-elected a Director of the Company.

Major S. FLOOD PAGE, one of the Directors of the Company, gave details of the patent actions in which the parent Company in London have been involved, and which have now ended successfully for the Company. He spoke hopefully of the position and prospects of the Manchester Edison-Swan Company.

A vote of thanks to the Directors brought the meeting to a close.

NEW COMPANIES REGISTERED.

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA (LIMITED). This company was registered on the 18th inst., with a capital of £50,000, in £5 shares, to carry on in the Australasian Colonies the business of contractors for the supply of electricity. The number of directors is not to be less than three, nor more than four; qualification, £200 in shares; the first are Viscount Torrington, J. F. Albright, of Chelmsford, and W. G. Whiffen, of Lombard-road, Battersea. Messrs. Harrison and Whiffen are appointed managers.

WOLVERHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This company was registered on the 18th inst., with a capital of £50,000 in £10 shares, to establish at Wolverhampton, or within a radius of 10 miles thereof, works for the production, storage, transmission, and use of light, heat, electric, magnetic or other force. There are 23 signatories for one share each, all of whom are resident in Wolverhampton and neighbourhood. The number of directors is not to be less than three nor more than eight, the first being Messrs. Alfred Hickman, Charles Wells, C. T. Mander, J. Ayre Sparrow, E. Pritchard, and T. J. Barnett; qualification, 50 shares or £500 stock: remuneration, £300 per annum and 10 per cent. on all divisible profits after payment of 7 per cent. dividend.

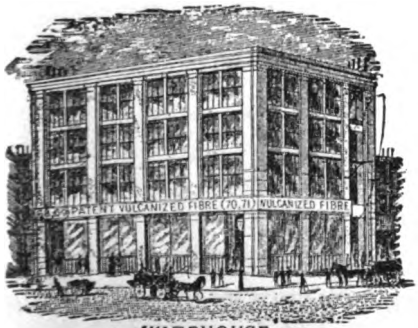
CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 14, 1889, amounted to £3,205, and for the week ended June 21, to £2,414.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 14, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,099, and for the week ended June 21, £1,567.

EDISON-SWAN LAMPS.—The Edison-Swan Company send us a notice of alteration in prices of their incandescent lamp. The alteration takes place as from the 1st July. It is further announced that a new and complete lamp list is in preparation. A copy of the notice can be obtained from the office of the company, at 100, Victoria-street, S.W.

THE NON-CONDUCTOR OF ELECTRICITY.



WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

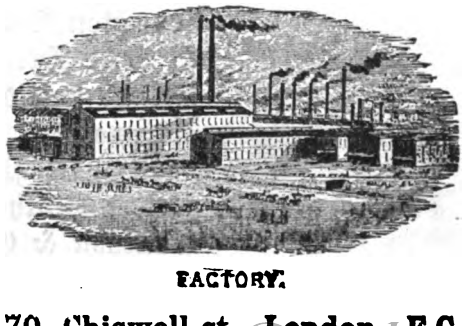
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50th. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, June 26, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending June 26, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	12/6	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	53½	52⅛
2,614,820	Stock	25/0	Do. Preferred	90 91	4 7 11	,, ,,	90⅞	89½
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	18⅜	18⅛
130,000	£10	5/0	Brazilian Submarine	12⅝ 13¼	5 6 8	Mar., June, Oct., Dec.	13⅛	13
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	19 20	5 0 0	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅞ 4¼	4 4 8	March & September	...	...
6,000	5	5/0	Do. Preference 10%	8½ 9½	5 5 3	April and October	...	...
66,710	20	3/6	Direct United States	10⅝ 10⅞	5 1 2	Jan., Apr., July, Oct.	10⅞	10⅝
380,000	10	2/6	Eastern	13⅛ 13⅜	4 9 9	,, ,,	13 5/16	13⅛
70,000	10	3/0	Do. 6 per Cent. Preference	14⅝ 15¼	3 18 8	,, ,,	15¼	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109	108
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	109½	...
250,000	10	5/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13 9/16	13 5/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	105½	...
179,177	10	3/0	Globe Telegraph and Trust	8 8½	5 0 0	Jan., Apr., July, Oct.	8¼	8
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 15	4 0 0	,, ,,	15	14⅜
150,000	10	5/0	Great Northern	15⅜ 16¼	4 12 4	Jan., July, and April	15 7/16	...
17,000	25	37/6	Indo-European	39 41	6 1 11	April and October	..	...
9,000	8	8/0	Reuter's	7 7½	5 6 8	April and October	7½	...
15,609	10	3/0	West African Telegraph	9 10	...	...	9⅜	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
30,000	10	2/0	West Coast of America	10 10½	5 14 3	January and July	...	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2½	2⅜
84,563	10	12/0*	Do. 1st Preference 6%	11¾ 12¼	...	April and October	12	11¾
4,669	10	...	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	9/0	Western Brazilian	11 11½	5 15 3	March & September	11½	11
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	118¾	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	100⅝	...
			TELEPHONES.					
224,850	14/0	4½d.	Consolidated Telephone and Maintenance ... xd	⅜ ⅞	...	Yearly	⅞	...
220,000	£1	3%	Oriental (11s. paid)	5/16 7/16	3 15 8	...	...	...
80,000	5	12/6	United xd	14½ 14¾	5 18 8	June and December	14⅞	14⅝
55,000	5	3/0	United River Plate	6¼ 6½	...	January and July	6⅝	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 4	...	...	...	...
23,692	5	2/0	Do. (fully paid)	4⅛ 4⅜	...	February & August	4⅛	...
79,934	5	...	Swan United (£3. 10s. paid)	3⅝ 4	...	...	4⅛	3⅞
			MISCELLANEOUS.					
37,350	12	36/0	Telegraph Construction and Maintenance	41 43	5 11 9	March and July	42½	42
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19 9/16	19

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 581.—Vol. XXIII. FRIDAY, JULY 5, 1889. Price Fourpence.

NOTES.

Although, as we learn, Lord Trayner's decision is to be appealed to the Inner House, the inducement to continue the struggle can be but small, seeing that the patent soon dies a natural death. Meanwhile the position of the large number of firms who have submitted to the payment of royalties is, at first sight, somewhat ludicrous. They may, however, take to themselves the consolation of believing that had the question been fought out in the English Courts the costs would unquestionably have far exceeded the total value of the royalties paid; and, moreover, without the least disrespect for the impartiality or the integrity of the judicial bench, we may add that it by no means follows that the decision arrived at would necessarily have been the same. We say this, not merely in view of the proverbial "glorious uncertainty" of the law, but especially with relation to the very singular circumstances of the case. Laying aside the altogether unimportant issue of the "cylindrical commutator with wearing segments detachably attached," in respect of which the Court would surely have permitted a disclaimer had the Brush patent been held otherwise valid, we come to this broad fact: Varley had not—at the date in question he could not possibly have had—the least idea of the use and purport of compound winding as applied in modern dynamos. What we understand of compound winding is something very different from a mere chance combination of shunt and series coils. That Varley was altogether oblivious of the possibilities involved in the modern applications of the device was frankly admitted by his counsel, who however imputed the same degree of ignorance to Brush at the date of *his* patent. On behalf of the latter, this aspersion has been vigorously denied; and although upon the crucial point of the attainment of constancy of potential his specification might well be more explicit, yet it is clear enough that he knew a good deal more about it than did Varley. In the light of these facts it must be difficult for anyone to feel any especial enthusiasm on behalf of either claimant. They each stumbled across an idea which happened to be capable of development into a remarkably useful device. One of them was certainly not looking for anything of the kind; the other was probably groping his way towards it, and at the very least must be credited with clearer views than any of his immediate contemporaries. To us it seems difficult to believe that the judicial mind must necessarily and inevitably take only one view of the question at issue—though we have not the least desire to insinuate that Lord Trayner's decision does not meet the justice of the case as well as any other.

At the very moment when the industry had hopes of the surcease of a burden, which, though by no means heavy, was no doubt somewhat vexatious, a far weightier and more onerous charge (if we are correctly informed) is sought to be laid upon it. Dynamos are not all compound-wound, but they have for the most part iron in their armatures, and the iron is invariably laminated. Our readers are already aware that in the United States a claim for the exclusive use of such armatures has been set up on behalf of an early patent of Edward Weston, and this claim has lately been recognised by the Edison Company. Here, however, the tables, it would seem, are to be turned, and Edison is the patentee whose rights in this country are now to be insisted on. On April 5th, 1880, a patent, No. 1385, was filed on behalf of Edison under the title of "Improvements in dynamo or magneto-electric machines and electric motors." This was one of Edison's somewhat unhappy "omnibus" patents, and included no less than ten claims, many of which are nowadays easily seen to be worthless, whilst others it would be difficult to construe as relating to one and the same invention. However, on July 12th, 1882, the Commissioners consented to the filing of a disclaimer by which all but a single claim was discarded. This claim reads as follows:—

"A rotating armature, composed of thin metal plates, discs, or rings as described, with alternating interposed insulating material secured together upon a shaft or hub, substantially as set forth."

This patent is now the property of Messrs. Mather and Platt, and why it has been allowed to rest in obscurity all these years, or why it is brought upon the scene at this particular juncture, we are at a loss to imagine. This firm also holds a patent (No. 15,648) of 1884, upon which we understand they are inclined to lay stress. Their specification, which was filed by Mr. W. Mather and Drs. John and Edward Hopkinson, describes several features which are common to modern dynamos, though whether the improvements are sufficiently definite in character to form a valid patent is possibly an open question.

The recent discussion on the influence of self-induction upon the working of alternators in parallel or as synchronous motors renders the publication by Professor Ayrton of the actual value of the self-induction coefficient in the case of several such machines singularly opportune. We trust that either Prof. Ayrton himself or others interested will add

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considerably to the number of such measurements. The introduction of the direct-reading variable standard of self-induction has much simplified the process, and although the secohmmeter is, no doubt, a rather expensive piece of apparatus, it ought to be regarded as indispensable for all workers in alternating currents. In reprinting this Paper, owing to the demands upon our space we have been obliged to omit the mathematical part of the section "On the Effect of Self-Induction in destroying Ripples," but the nature of the results arrived at will easily be understood from the abstract.

BUT perhaps the greatest interest attaches to the simple and ingenious device which Prof. AYRTON calls the Electric Frequency Meter, and which we have lately had the pleasure of examining at the Laboratory in the Exhibition-road. It is unfortunate that the difficulty of providing a suitable alternating current precluded an exhibition of these experiments before the Institution of Electrical Engineers. Had this been possible we are sure that much interest and enthusiasm would have been aroused. At the time of our visit, although the apparatus had not been carried beyond the earliest experimental stage, the results were attained with great ease, and it was extremely curious to hear the wire conveying the current break into loud sonorous vibration as soon as its free length had been adjusted to suit the period of alternation. The overtones corresponding to "ripples" on the current-wave were only faintly heard, but by a suitable choice of diameter, material, and stretching force applied to the wire, there can be little doubt that an appliance of great scientific interest, and perhaps also of some practical value, may easily be perfected.

WE may also mention that for some time past several of Prof. AYRTON'S students have been engaged (under his direction) in a very extensive and elaborate investigation upon the efficiency and output of secondary batteries. Already some results of a curious and unexpected character have been arrived at. It was very soon discovered that what is sometimes called the "ampere-hour efficiency" might in a single experiment be almost anything you please, and might easily exceed 100 per cent. *according to the previous history of the cells.* It is therefore necessary before drawing any conclusion that the battery should be regularly charged and discharged with precisely the same number of coulombs for a sufficiently long period to bring it as nearly as possible into a perfectly normal condition. For this purpose and for subsequent accurate measurements a system of automatic control of the charge and discharge has been devised, which, although decidedly complex in appearance, does its work in a most effective manner. We look eventually for a Paper of great interest—one which will probably throw light on some of the most obscure phenomena of the secondary battery—as the outcome of these experiments.

THE able and suggestive article on "Problems in Electric Traction," by Dr. LOUIS BELL, which we reprint this week from the *Electrical World*, will doubtless be read with interest by those who are connected with electric traction in this country. Dr. BELL, we are glad to see, re-echoes our oft-repeated opinion that an ideal solution of the many difficulties besetting electric traction would be furnished by batteries, "if the storage battery comes to be of reasonable durability and weight." With respect to the very low commercial efficiency (25 per cent.) of the Lafayette line, Dr. BELL puts the saddle on the right horse when he remarks that the key to the whole situation lies in the immensely irregular calls for power, and suggests as the best remedy the employment of engines specially built to meet the exigencies of tramway work, the problem being "to work an engine on the average at its most economical point of cut-off, while retaining the power to respond to sudden, though brief, demands for several times the average horse-power." The article is full of good points, for which we must refer our readers to our reprint, or to the excellent summary in our American correspondence.

THERE would seem to be good reason to believe that the puzzling phenomenon of the dark flash has at last received a satisfactory explanation. Mr. A. W. CLAYDEN, at the last meeting of the Physical Society, exhibited some photographs, copies of which will be found elsewhere in this issue, showing both "natural" and artificial dark flashes. After all it seems to be merely a photographic effect due to the presence of white clouds in the background. The author referred at the meeting to one difficulty which seemed to require explanation, viz., the crossing of a dark flash by a bright one, but he has since informed us that he has succeeded without difficulty in reproducing the phenomenon, the point of crossing appearing to be extra bright, just as in the case of the photographs of lightning.

WE are indebted to the editor of *L'Elettricità* for some interesting information respecting the recent discovery of an important manuscript of GALVANI'S, to which we referred in our issue of the 31st May. A manuscript belonging to GALVANI has, it seems, been actually found in the Communal Library at Bologna, though it is not the manuscript of an unknown treatise by the great *savant*, the work to which it belongs being "De viribus Electricitatis in motu musculari," which was published about the year 1792. The discovery is, however, of considerable historic interest on account of the large number of marginal notes in GALVANI'S own handwriting which this treasure-trove contains.

IT will be noted that in the last letter of the Board of Trade to the London County Council the duties of Electrical Inspectors as regards meters are spoken of as if they were confined merely to certifying them "to be of some construction and pattern, and to have been fixed and to have been connected with the service lines in some manner approved of by the Board of Trade." This would be satisfactory so far as it goes; but, as we pointed out last week, the Model Order further prescribes that the Inspector shall certify every meter "to be a correct meter."

MR. EDISON, we are glad to learn, has definitely promised by telegram to visit the Electrical Exhibition at Birmingham in August, and steps are being taken to give him a fitting reception. The opening of the Exhibition is fixed for the 1st August.

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Wakefield.—A London company will apply to Parliament in the next session for powers to light this town by electricity for public and private purposes.

Personal.—We learn that Mr. R. J. Browne, who was assistant electrician at Glasgow International Exhibition, has left this country to fill an important position in India.

An English Westinghouse Company.—We understand that an English branch of the Westinghouse Company is being organised, and will probably come out in the course of a few days.

A Correction.—In the description of the Elmore Process in *The Electrician*, June 14th, the current density should be 15 amperes per square foot of cathode, not "square inch" as stated.

Dublin.—On Saturday last the solicitor for the Irish House-to-House Electricity Company served a notice on the Corporation, announcing the intention of that Company to apply for a Provisional Order.

West African Telegraph Company.—The numbers of the Five per Cent. Mortgage Debentures of this Company, which will be paid off on the 2nd September next, will be found in our advertisement columns.

Bradford.—The municipal electric light station at Bradford is so nearly complete that a trial of the engines and dynamos is to be made in a day or two. In a month or six weeks, it is expected, light will be supplied to customers.

The Society of Arts Conversazione.—The Conversazione given by the Society of Arts at South Kensington last Friday was of a very brilliant description. The guests, who were received by the Duke of Abercorn, C.B., numbered upwards of two thousand.

Segovia (Spain).—The streets of Segovia will shortly be lighted by two 300 candle-power, ten 50 candle-power, and two hundred 16 candle-power incandescent lamps. The motive power for the dynamos is obtained from a waterfall, about a mile from the town.

Plymouth.—A company called the Devon and Cornwall Electricity Supply Company has been formed at Plymouth for the purpose of establishing a central station from which electricity can be supplied over a large radius, including Devonport, Stonehouse, and the suburbs.

Royal Institution.—At the general monthly meeting of the Royal Institution on Monday last Messrs. Robert Kaye Gray, James Mactear, William James Russell, and James Miln Small were elected members. Sir James Crichton-Browne, M.D., F.R.S., was elected treasurer of the Royal Institution.

Barmen.—We are informed by Herr Paul Bürsche, who was responsible for the accumulator arrangements of the Barmen central station, about which we gave a few particulars in our last issue, that the dynamos are only worked as a rule four hours per diem, in lieu of 10 hours, as stated in the note in question.

Frankfort-on-the-Main.—In Frankfort-on-the Main the long-debated question whether the town should undertake the private electric light supply, or leave it to a company, has been settled in favour of the supply being undertaken by the town. It is expected that the works will be in going order by the 1st of October.

Horfield Local Board.—At the last meeting of this Board letters were read from the Electric Lighting Maintenance Company (Limited), London, and the Western House-to-House Electric Lighting Company (Limited), stating their intention to apply to the Board of Trade for a Provisional Order to introduce electric lighting into the district.

Important Sale of Plant and Machinery.—We would draw the attention of our readers to the fact that this day (Friday) is the concluding day of the important sale by Messrs. Wheatley Kirk, Price and Goulty, at the Suffolk Works, Berkley-street, Birmingham, of the plant, machinery, stock, stores, and utensils announced in our advertisement columns last week.

Whipple's Electrical Publications.—Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C., have taken up the agency for Mr. Whipple's publications, several of which are well known in this country. They include his book on "Municipal Lighting," the second annual number of which has just appeared, the "Electric Railway," and his "National Electrical Directory."

Chatham.—At a meeting of the Chatham Local Board of Health on Friday last a letter was received from the Chatham and Rochester Electric Lighting Company, asking the Board to consent to an application for a Provisional Order by the Company. It was resolved, after considerable discussion, that the Board must have a copy of the proposed Order before considering the matter further.

"The Steamship."—A new monthly journal, called *The Steamship*, appeared on the first of the month. *The Steamship* is to be a scientific journal devoted to the interests of marine engineers, shipbuilders and shipowners. Amongst the articles contained in the first number we notice one on "Electric Lighting," by G. J. Burns, B.Sc., and an illustrated description of the Cox-Walker-Swinton Magneto-electric Signal Bells for ships.

Underground Electric Light Cables.—Up to the present time, says the Berlin correspondent of *Industries*, the joints between the lead cables which are used in connection with the Berlin central electric light stations were made by special clamps, it having been considered impracticable to make soldered joints between heavy cables; but now one of the engineers of the company has invented a method of soldering even the heaviest cables, whereby injury to the insulating material is avoided, the application of heat being purely local.

An Advantage of the Telephone.—The advantage of the use of the telephone in assisting the police to discover or to prevent crime was recently strikingly exemplified in Dundee. A servant noticed a man climbing over the wall of an empty house close by. She immediately apprised her mistress of the circumstance. The house being connected by telephone, the lady promptly called up the Central Police Office, the result being that within a few minutes the residence was surrounded by a cordon of police and the would-be burglar was soon captured.

St. Margaret's and St. John's Vestry.—At a meeting of this Vestry, on Wednesday, last week, the Parliamentary Committee reported upon the recent inquiry held by Major Marindin, and recommended "that the Vestry reserve its consideration of the schemes for the lighting of the parishes by electricity and the proposed Provisional Orders until the Bill relating thereto has been introduced into Parliament, and that the Board of Trade be informed accordingly; and that the Committee be authorised, in case of necessity, to petition against the Bills affecting the parish." The recommendation was agreed to.

Electric Light Experiments at the Entrance of the Solent.—Some electric light experiments which were carried out at the beginning of last week at the Needles resulted in favour of the light. Six gunboats and six torpedo boats left Portland with the intention of forcing a passage at the entrance of the Solent, hoping by raising thick volumes of smoke to conceal their presence. But, steaming head to wind, the smoke was carried astern, and each vessel was distinctly seen several miles off, and, with the aid of powerful glasses, the numbers of the torpedo boats were read as soon as the vessels came within range of quick-firing guns.

Postal Telegraph Revenue.—The Revenue returns for the quarter ended 30th June show an unusually large augmentation of the gross receipts from the Telegraph Service. Compared with the June quarter last year there has been an increase of £45,000; and on a comparison of the annual periods ending June 1888 and June 1889, the increase during the latter amounts to £160,000. Details for the four quarters of the two years are as follows:—

	Sep. 30.	Dec. 31.	Mar. 31.	June 30.	Total.
1888-9	£565,000...	£515,000...	£520,000...	£525,000...	£2,125,000
1887-8	540,000...	465,000...	480,000...	480,000...	1,965,000
Increase ...	£25,000	£50,000	£40,000	£45,000	£160,000

Proposed Telpher Line between Brechin and Edzell.—A meeting of gentlemen interested in the construction of a telpher line between Brechin and Edzell was recently held at Brechin. Mr. Manville, of the United Electrical Engineering Company, explained the construction and working of the system, and

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stated that he estimated the cost of the proposed line, which will be about six miles in length, at about £16,000. The speed would be about twelve miles an hour for a train of five carriages, each holding five passengers, and the trains would be despatched in quick succession—say, one every half-hour. Those present at the meeting expressed themselves very favourably disposed to the project, and the landowners on the route seemed willing to give way-leaves for the erection of the posts. It was agreed to provide funds for preliminary expenses.

The French Government and the Telephones.—It will be seen by the following resolution, which was passed unanimously at the last meeting of the shareholders of the Société Générale des Téléphones, that the proposals of the French Government (*The Electrician*, June 21, p. 160) are likely to meet with a determined opposition in this quarter:—"The shareholders of the Société Générale des Téléphones, after having heard the explications given by their Board with regard to the purchase scheme proposed in the Chamber of Deputies, consider that these proposals constitute a breach of previous agreements, and amount to a veritable confiscation. They, therefore, protest against the scheme, approve of the conduct of the Board in the past, and rely on their firmness in the future." It should be mentioned that proceedings have already been taken against the State to enforce the carrying out of the convention of July 22, 1886.

Proposed Dinner of the Institution of Electrical Engineers.—The following circular has been issued to the members of the Institute, and it is to be hoped that it will meet with such a response as to justify an annual fixture:—

Dear Sir,—I am instructed by the Council to inform you that it is proposed that the Institution should hold a dinner, on the 4th of November next, to which a certain number of distinguished guests would be invited. In order to enable the Council to form some approximate estimate as to the provision to be made as regards numbers, it is desirable that they should ascertain as soon as possible what members are likely to attend, and I have to request therefore the favour of your informing me whether you will be disposed to do so providing you find your engagements will so permit. The price of the dinner tickets will not exceed 10s. 6d. exclusive of wine. Should the Council find that the feeling of the members generally is in favour of the dinner being made an annual institution, they will make arrangements accordingly.—I am, dear sir, faithfully yours, F. H. Webb, Secretary.

Electrical Conferences at the Paris Exhibition.—The Société Internationale des Electriciens has organised a series of "conferences-visites," which will take place every Tuesday and Thursday. These conferences will commence at 10 a.m. at places previously announced:—

July 4.—M. Napoli: Apparatus of Precision.
,, 9.—M. Sarcia: Accumulators.
,, 11.—M. Seligmann-Lui: Telegraphy.
,, 18.—M. Hospitalier: Commercial Measuring Instruments.
,, 23.—M. le Capitaine de Place: Military Electrical Apparatus.
,, 25.—M. Dumont: Railway Apparatus.
,, 30.—M. Hillairet: Motors and Transmission of Power.
Aug. 1.—M. de la Touane: Telephony.
,, 6.—M. Arnoux: Continuous-current Dynamos.
,, 8.—M. Lemonnier: The Applications of the Electric Light in the Army and Navy.
,, 13.—M. Picou: Alternators and Transformers.

Portsmouth.—On Thursday evening last week, at the invitation of the South Hants Electric Supply Company, a meeting was held at the Esplanade Hotel, Southsea, for the purpose of listening to a short address by Mr. Bate, representing the Laing, Wharton and Down Construction Syndicate, on the Thomson-Houston system of electric lighting, which has just been temporarily installed at that hotel. Mr. Bate, after explaining the Thomson-Houston system, said that the Corporation had refused to give the South Hants Company permission to run overhead wires temporarily, pending the obtaining of the Provisional Order for which they had applied. He could not help feeling that it had been refused under a misapprehension that they sought a permanent permission. They had already over 100 orders in different parts of the town, but they could not proceed to execute them until their Provisional Order was out. In the course of a discussion which followed, it was mentioned that the Roads and Works Committee had received an application from another company for their consent to a Provisional Order.

Wimbledon.—At the last meeting of the Wimbledon Local Board, the members had under consideration a proposal by the South Western District and Thames Valley Electricity Supply Company (Limited) to supply electricity to a large district, embracing Wandsworth, Wimbledon, New Malden, Surbiton, Kingston, Ham, Richmond, Mortlake, Barnes, Kew, and Putney. The company was registered on Friday last with a capital of £100,000 and power to increase. Contracts will, after the Provisional Orders have been obtained, be entered into with responsible firms to lay underground mains throughout the district, capable of supplying 100,000 lamps from three centres at Kingston, Mortlake, and Wandsworth respectively, and to supply generating plant for 50,000 lamps at once. The contractors will also work the stations and supply the current required, the charge per Board of Trade unit being 4½d. The projectors claim that they enter upon the work under the most favourable conditions. The Chairman of the Board remarked that it was one thing for the Company to show their sanguine figures on paper, and another to realise them after a few years' experience. The Company's communication was referred to the Electric Lighting Committee. It is stated that the Board are also applying for a license to enable them to light the district under their jurisdiction by means of electricity.

Electro-motive Force of Amalgams.—Experiments on the E.M.F. of amalgams immersed in an electrolyte such as zinc sulphate or dilute sulphuric acid have been made by Crova, in Germany; Gaugain, in France; and Hockin and Taylor in England. It was found that excessively small traces of zinc or cadmium made a marked difference in the E.M.F. of mercury. Thus an amalgam investigated by Hockin and Taylor, consisting of 1 part zinc to 23·6 million parts of mercury in sulphate of zinc, was discovered to be more positive than pure mercury by 0·01 volt, and an amalgam composed of 1 part cadmium in 5·7 million parts of mercury was shown to be more positive than pure mercury by 0·09 volt. A German scientist, Herr S. Lindeck, in a recent Paper, contributed *Ann. Phys. Chem.* [2], 35, 311-331, describes a series of experiments that he has made on amalgams of zinc, cadmium, silver, lead, and tin. The results of this investigation are graphically exhibited by means of curves, in which the percentage of the metal alloyed with the mercury is plotted against the corresponding change in the difference of potential. Hockin and Taylor's results are confirmed, and by comparing these curves Lindeck infers the following conclusions:—1. The higher the position of a metal in the electromotive series, the higher will the addition of a slight trace of it raise the position of mercury in the series. 2. A further addition of metal produces scarcely any effect; the amalgam containing a mere trace of the metal occupies practically the same position in the series as a bar of amalgamated metal. 3. In whatever proportions silver and mercury be amalgamated, the amalgam occupies approximately the same position in the series as that occupied by pure mercury.

Lambeth Vestry.—At a meeting of this Vestry last week the Clerk made a lengthy statement upon the subject of the London and Metropolitan Electric Lighting Orders. The result of the long inquiry which took place before Major Marindin was that the London Company were allowed an Order for that part of Lambeth north of Westminster-bridge-road, while the Metropolitan Company were allowed the whole of the parish. Before the Board of Trade considerable discussion took place on the question of the Metropolitan Company laying wires in various parts of the parish, and their representative eventually agreed to lay them down on the Albert-embankment, South Lambeth-road, Kennington-road, Kennington-park-road, Clapham-road to the Swan, and Brixton-road to the church, in addition to some half-dozen important roads in the north of the parish. He was, therefore, much surprised on receiving a letter from the Company stating that, beyond the streets in the northern parts and the Clapham-road, they could schedule none, because they were the only ones in which in the immediate future there was any likelihood of there being any demand for electric lighting. Under those circumstances he (the Clerk)

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felt justified in advising the Vestry to strongly oppose the Order, unless the Company did justice to the southern parts of the parish. The Electric Lighting Committee presented a report in accordance with the Clerk's statement, and the report was adopted.

Leeds.—On Wednesday last Mr. Lee Hardwick moved that the Council authorise the lighting by electricity of such portions of the Town Hall and Municipal Buildings mentioned in the report of the Electric Lighting Committee (the substance of which we published in our last issue), at an estimated expenditure of £3,000.—The resolution was unanimously adopted.—Mr. Lee Hardwick next moved that the Council apply to the Board of Trade for a Provisional Order authorising the Corporation to supply electricity for public and private purposes within the area referred to in the Report, at an estimated total capital expenditure of £68,000.—Mr. Battle moved an amendment to the effect that it was not desirable for the Corporation to supply electricity for public or private lighting purposes, as in the opinion of the Council such supply could be advantageously provided by private enterprise. They were asked, he said, to embark in an enterprise of a most speculative character, and there was not a single member of the Committee who supported it that would invest his own money in it if it were to be carried out by the Electric Lighting Committee. He could not understand intelligent business men undertaking such a scheme for a moment.—After considerable discussion the amendment was lost, whereupon Mr. Kettlewell moved another, to the effect that the question be referred back to the Committee to report further, especially as to the annual cost of the present installation, and as to the cost in other towns where the electric light had been adopted.—This having been seconded, was adopted.

Electric Energy and Light.—Under this head Mr. J. W. Moore, of Lafayette College, Easton, U.S., writes as follows to our esteemed contemporary, the New York *Electrical Engineer*:—

Apropos of the recent experiments of Prof. Stone on electrical energy and light, I send you some struggles after the relations between these two physical conditions. They were unsuccessful—that is, the results were negative—but sometimes I imagined that I did observe a slight change in the intensity of sound in the telephone. They will illustrate some of the gropings after the truth which are now going on. I copy from my laboratory note book for 1884:—

Experiment 1 was a repetition of Faraday's experiment of the rotation of the plane of polarisation of light by magnetism.

Experiment 2.—The analyser was removed; a piece of unannealed glass was wound with fine insulated wire; the wire was connected with a Bell receiver. The glass having been placed in front of the polariser the latter was made to rotate rapidly on its axis. No sound was heard in the telephone.

Experiment 3.—The polariser was fixed; the glass and telephone were allowed to remain as in experiment 2. A cardboard disc, perforated with a series of holes arranged in a circle, attached to a rotator, was made to rotate with various velocities in the path of the light entering the polariser. The light was thus divided into a great number of paths. No sound was heard in the telephone.

Experiment 4.—The siren was removed, everything else remaining the same. The glass was subjected to pressure with a screw. When it was alternately compressed and released from pressure no sound was heard in the telephone.

Experiment 5 was the same as 4, except that the glass was permanently compressed and suddenly passed through the beam of light.

Experiment 6.—The preceding experiments were all repeated with two telephones in circuit, opposite one of which a tuning-fork was placed. No change was noticed in the intensity of sound.

Experiment 7.—A Hughes' sonometer was introduced in a microphone circuit. The glass and other bodies surrounded by their coils were placed singly in the microphone circuit. The telephone failed to show any change in the ticking of the watch on the microphone stand when all the previous experiments were repeated.

Experiment 8.—A Hughes' induction balance was placed in circuit. All the previous experiments were reproduced with similar results.

Many variations were made in the length and diameter of the wire. The material was changed. Pressure was applied transversely and longitudinally. A soft iron core was also placed in the coil of wire. When the microphone was placed in circuit, it was found necessary to remove the watch and substitute an electric vibro-scope. The battery was also changed to get rid of variations in strength of current. The "frying" noise of the microphone was obviated by changing the form of the instrument, so that a smooth sound of constant intensity was heard.

The Birmingham Exhibition.—The following is a list of the chief electrical firms who will take part in the forthcoming Electrical and Industrial Exhibition at Bingley Hall, most of whom will send working exhibits:—Acme Electric Works—electric light and telegraphic apparatus; Admiralty—Whitehead torpedos (whole and section), submarine electric mines, electric exploders, batteries, keys, switches, Wheatstone bridges, lamps and other electric apparatus for torpedo service; Anglo-American Brush Electric Light Corporation (Limited)—engines, Brush dynamos, arc lamps, incandescent lamps, Mordey dynamos, transformers, &c.; Appleton, Berbey and Williams—switches, batteries, electric light fittings, &c.; Avery, W. and T.—Snelgrove electric weighing machine, weighing for general purposes and bullion, chemical and other sensitive balances, Snelgrove's patent electric beds, &c.; Buller, Jobson and Co.—telegraph poles, fittings for telephonic and electric light purposes, articles in porcelain; Callender Bitumen Telegraphic and Waterproof Company (Limited)—electric light mains and underground systems as used in London, Liverpool, on the Continent and United States; Canning, W., and Co.—dynamos, vats, solutions, chemicals, and all things required for electro-depositing; Coad, T.—batteries, lamps, &c.; Corporation of Birmingham (per Mr. Prime)—the first dynamo constructed for depositing metal; Crompton and Co.—electric lighting, electric crane, &c.; Crossley and Co., gas engines, dynamos, lighting, &c.; Cruickshank, R.—dynamos, machines for electro-depositing, regulators, switch-boards, &c; Davis, J., and Son—electric light fittings, &c.; Eclipse Electrical Case Works—cases for electrical telephone batteries, &c.; Edison and Swan United Electric Light Company (Limited)—electric incandescent lamps and fittings, electric miners' lamp, &c.; Electrical Power Storage Company (Limited)—accumulators for central lighting, &c., automatic switch batteries, &c.;—Elwell-Parker (Limited)—dynamos, batteries, motors, &c.; J. Fowler and Co.—samples of lead-covered cables, joints, &c.; Fowler, Lancaster and Co.—electric lighting plant, fittings in wrought iron, copper, &c., *spécialité* in switches and presses in porcelain, &c., dynamos and gas engines; Frictionless Engine Packing Company—electric frictionless engine packing; Hartley and Co., plating dynamo, *spécialités* in electro-plating, &c.; N. T. Henley—table with case containing coils of electric cable for electric light, &c.; General Electric Company—electric appliances; Glover and Co.—cables, wires, &c.; A. A. Goldster—electric lamps (arc and incandescent), electric light fittings, &c.; The Gülcher Electric Light and Power Company (Limited)—dynamos, motors, arc lamps, &c.; Hand and Co.—lightning conductors; Hateley and Lea—electric fittings, chandeliers, &c.; Immisch and Co.—tramcar electric motor, constant-current motors, &c.; Julien Electric Company—electric tram car; Lacombe and Co.—all forms of carbon for electric use, &c.; Laing, Wharton and Down—electric lighting, electric welding, &c.; Laurence, Paris and Scott—dynamos, motors, &c.; London Electric Wire Company—covered wires and cables for electric purposes; Muller, C. A.—electric measuring instruments manufactured by S. Schuckert (Nuremburg), electric light carbons, &c., manufactured by C. H. Schmelzer; Mayfield and Co.—special Wimshurst electric machines, electric apparatus, &c,; Nalder Brothers—reflecting and other galvanometers, resistance coils, Wheatstone bridges, &c.; Planet Electrical Engineering Company—dynamos, arc lamps, lighting, &c.; Scott and Co.—electric lighting, dynamos, switch-boards, &c.; Shippey Brothers—electric lighting, dynamos, lamps, motors, batteries, &c.; the Schanschieff Electric Battery Syndicate Company—batteries, lamps, &c.; Thonet Brothers—electric lathes, chandeliers; United Electric Engineering Company—telpherage, &c.; Woodhouse and Rawson—switches, incandescent lamps, switch-boards, motors, &c. The cages, fans, &c., of the coal mine will be worked entirely by electric motors, and the various systems of hand lighting will be shown.

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REVIEWS.

Physical Memoirs, Selected and Translated from Foreign Sources under the direction of the Physical Society of London. Vol. I. Part I. (Messrs. Taylor and Francis, 1888.)

(FIRST NOTICE.)

In addition to publishing the collected memoirs of some of our leading physicists, as has already been done in the case of Wheatstone and Joule, the Council of the Physical Society decided some time ago upon issuing from time to time a series of translations of important physical Papers communicated to various foreign periodicals. There is no doubt that the series will be one of great value, and it will be something of the same character as the physical portion of "Taylor's Scientific Memoirs" which was started a good many years ago, but unfortunately could not be carried on as it was found impossible to make the undertaking a self-supporting one. The rate at which the present series will be issued will depend upon the funds at the disposal of the Society for the purpose, and as it is now increasing its numbers considerably, we trust that this rate will soon be accelerated. The present instalment consists of a selection of some of the most important of Prof. von Helmholtz's Papers bearing on the chemical relations of electric currents. The first four of these, namely, "Studies on Electric Boundary Layers" and three Papers on the "Thermo-Dynamics of Chemical Processes," have been translated by Mr. E. F. J. Love, M.A., of Mason's College, Birmingham, and the fifth and concluding Paper, entitled "Further Researches respecting the Electrolysis of Water," has been translated by Prof. S. P. Thompson. The translators' work has all through been exceedingly well done.

It is pointed out in the first of these Papers that the theory which has hitherto been held of the distribution of electricity among a system of conductors leads to the conclusion that electricity existing in equilibrium upon one or more conducting bodies forms an infinitely thin layer on their surfaces, leaving the interior portion completely free. Experimentally it is quite clear, from experiments in which an electrified conductor is allowed to discharge itself into a separate insulated conducting envelope, and its electrical condition investigated after the envelope has been removed, that this layer is really extremely thin, and that if any quantities of electricity are retained within the mass of a conductor they can only be vanishingly small. As long as it is a question only of a simple electric boundary-layer, or a conductor in contact with other conductors or insulators without any discontinuity in the value of the potential, no difficulty is presented by the supposition of a finite quantity of electricity spread out in an infinitely thin layer, and therefore of infinite volume density. For the energy of any one portion of a charge of this kind being proportional to the product of the quantity of electricity at the given point into the value of the potential at that point, remains finite. This is not the case, however, when there is a discontinuity in the potential at the surface of separation between two bodies; and in order that a difference in the value of the potential may be exhibited an electric double layer must be formed at the bounding surface. The most familiar example of such a condition of things is given by the case of two conductors in contact with an E.M.F. of contact between them. In this case there will be a positive charge upon one plate, and an equal negative charge upon the other, and if the two plates are kept in metallic contact by means of a wire, while their surfaces are made to approach each other, the accumulation of electricity upon the plates gradually increases as the distance diminishes, but always in such a manner that the product of the distance between the two plates into the density of the distribution on either always remains constant. The author calls this product the moment of the electric double layer. This moment is equal to the potential difference existing between the plates divided by 4π, and as this potential difference remains of constant magnitude, even if the plates come into the same perfect contact as that at the already existing point of connection, the moment of the electric double layer must even in this case remain constant. Sir William Thomson has pointed out that a certain definite amount of work, which he shows how to calculate, is expended in forming an electric double layer. This work may be done either mechanically, by the attractive forces between the two plates charged by contact with one another, or thermally, if the plates are brought near together on insulating stands, and then connected by means of a wire, so as to allow them to become charged. The work expended in heating the wire would, according to his formula, be infinite if the distance between the plates could be reduced to zero, and therefore the density of electrification would also become infinite. Sir W. Thomson, however, maintains that the expenditure of work for the greatest possible extension of surface of two given metals cannot exceed the mechanical equivalent of the heat developed in melting them together, as in this case their combination is more complete than would be the case if leaves however thin of the metals were simply laid one upon the other. If the leaves can be made so thin as just to receive the double layer, the maximum expenditure of work would be attained. In this way a minimum value of the distance between two leaves may be determined, and Sir W. Thomson estimates it at the thirty-millionth of a millimetre (*Nature*, March 31 and May 19, 1870). In the case of metallic electrodes in an electrolyte which cannot be decomposed by the E.M.F. employed, we have an example of molecular contact between two conductors with the possibility of a variable discontinuity of potential. There will here be an electric double layer of which the moment corresponds with the sudden change of potential existing at the time from the electrode to the fluid; and this double layer, which is set up at the surface of the electrodes, under the influence of the polarising current, must be capable of discharging itself in the depolarising current, so far as it is not dissipated by diffusion or by residual metallic conduction in the electrolyte. The force which causes this accumulation of electricity on the bounding surface of two metals in contact must—as the author pointed out in his Paper, "Ueber die Erhaltung der Kraft"—be due to different attractions of different metals for electricity. The author, therefore, assumes that for every metal there is a certain quantity, K, which expresses the amount of potential energy represented by the attraction of the metal for a positive unit of electricity at a distance which is great compared with the molecular forces; this quantity will accordingly be lost when the unit of electricity passes within the interior of the metal. It is easy to see that this hypothesis leads to the ordinary law of the electromotive series. This law only holds for bodies which conduct without electrolysis and are at the same temperature. In these, the electricity tends towards a condition of equilibrium. The maintenance of a continuous current when an electrolytic conductor is interposed, may be explained by the fact that a chemical transformation is going on in the electrolyte, and therefore the attainment of static equilibrium in impossible. The work K is done by a force which only begins to act at molecular distances, and, therefore, the change in the value of K, in passing from one metal to another in contact with it, may be supposed to take place, not suddenly, but continuously within a boundary layer with a breadth of the same order of magnitude as the sphere of action of the molecular forces. There is no reason why the force producing the work K should not exist in the case of insulators as well as of conductors, and this assumption leads to a very simple means of explaining the phenomena of frictional electricity. When two metals are separated from each other the charges remaining on them will vary greatly, as they will depend upon their relative position at the moment when the last contact occurred, but if one or both be insulated there can only be a very incomplete discharge. The author then shows by a simple calculation that very high values of the potential may be attained in this way. The calculation shows that if the insulation were perfect an E.M.F. even much smaller than that which exists between copper and zinc would be capable of giving rise to such actions as are exhibited by frictional electrical machines, and they show, moreover, that the essential requisite for success in obtaining powerful action is the complete absence of conductivity on the part of at least one of the bodies rubbed together. The result is in complete accordance with experiment. We may therefore regard friction under moderate pressure as the means of obtaining a complete and widely-extended contact between two electrically

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different bodies. The author calls attention to the fact that the potential series for frictional electricity is very incompletely determined and that the relation between two bodies shows great variability even when no change in the surface in contact is perceptible. This, however, becomes comprehensible when we remember that it is only a superficial layer, perhaps not exceeding the millionth of a millimetre in thickness, which takes part in the action. This thin layer may vary without our cognizance, it may be detached by friction and electrification developed between it and the interior; or, again, as the author suggests, other charges may have left behind their residua on the insulator and have become inactive externally on account of the opposite charge of the surface. If the surface charged, however, is torn off by friction the earlier electrification may become apparent, and this would explain many of the irregularities arising in the friction of bodies which come close together in the potential series. While the rubbed bodies are close together the electric double layers are held fast by the attraction of the molecules of matter, and the value of the potential is a minimum since the opposite layers are close together. When they are separated their potential will rise rapidly and sparks may pass between the strongly-charged insulator and conductor, consisting obviously in the transport of electrified particles. The partial combination of the opposite electrifications might take place immediately behind the line of separation between the two surfaces, supposing one of them to be a sufficiently good conductor to allow of the rapid flow of electricity needed for a spark discharge. In frictional electrical machines this is prevented by attaching a strip of silk to one edge of the cushion, covering the edge of the glass disc or the surface of the cylinder for some distance from the amalgamed rubber. This silk covering stands in the same electrical relation to the glass as the amalgamed surface. The electric double layer then remains bound, in consequence of the molecular force, up to the edge of the silk where no sensible spark discharge can take place. The cushion itself must be well connected to earth in order to carry away the negative electrification, so that the rubber practically consists of a combination conducting at the beginning and insulating at the end. This springing back of the charge across the line of separation may easily be seen by removing the silk and working the machine in the dark, when a series of brush charges will be observed between the cushion and the glass which has just passed it. When the silk is in its place no discharges will be seen between its edge and the glass. In some experiments which he made, the author found that about half the electricity was lost by these discharges when the silk covering was removed. That even the best insulators possess some conductivity is shown by the residual charge of the "Leyden" jar, and by Wüllner's investigation, according to which the electrification of an insulator ultimately distributes itself exactly as on a conductor. The electric charge of the boundary layers on two insulators in contact may therefore quite possibly be produced in the same way as in metals. As the distance through which the electricity would have to be driven can be measured only by millionths of a millimetre, and the fall of potential within this space is finite, there will be a very high E.M.F., and therefore large transferences of electricity in a short time, even if the attainment of complete equilibrium requires some hours, as in the case of the residual charge. The fact that with the ordinary electric machines a unit-jar can be charged with fewer turns when the rotation is slow than when it is rapid shows that the time of passage through the cushion is not sufficient to charge the glass completely.

Issue of Provisional Orders.—Notice has been given that the Board of Trade have issued a Provisional Order under the provisions of the Electric Lighting Acts, 1882 and 1888, with a view to the same being included in a Confirmation Bill about to be introduced into Parliament, to the Kensington and Knightsbridge Electric Lighting Company and to the Chelsea Electricity Supply Company, authorising them to supply electricity for public and private purposes within certain portions of the parish of St. Mary Abbot, Kensington.

TELEPHONE COMPANIES AND THE POST OFFICE LICENSE.

The following embodies the chief features of the Draft License under which the companies carry on telephonic business by permission of the Postmaster-General:—

THIS INDENTURE made the day of , One thousand eight hundred and eighty- , between , Her Majesty's Postmaster-General (who and his successors in office for the time being are intended to be hereinafter included in the term "the Postmaster-General"), on behalf of Her Majesty of the one part, and the Company (Limited), the registered office of which is at No. (hereinafter called "the Company"), of the other part.

WHEREAS, under or by virtue of the Telegraph Acts, 1863 to 1878, and the Acts of Parliament, charters, grants, and agreements therein referred to, and of divers conveyances, awards, and assurances, executed in pursuance of the said Acts or some or one of them, the Postmaster-General has power to construct and work telegraphs, and to grant leases and licenses and enter into agreements of and with respect to telegraphs and telegraph undertakings and the working and using thereof.

AND WHEREAS the Company have been formed for the purpose amongst other things of carrying on the business of constructing, manufacturing, maintaining, working, and using telegraphs consisting of wires, telephones, and other transmitting and receiving instruments and other telegraphic apparatus and of permitting and aiding in the working and user of such telegraphs as aforesaid, and of selling and letting on hire such telegraphs as aforesaid for the purposes of such working and user as aforesaid.

AND WHEREAS by reason of the provisions of the said Acts such part of the said business of the Company as is intended to be hereby licensed cannot be carried on without the license or sanction of the Postmaster-General.

AND WHEREAS at the request of the Company and in order to enable them to carry on the said business in manner hereinafter authorised, the Postmaster-General has agreed to grant to the Company the licenses, powers, and authorities hereinafter expressed and contained for the period upon the terms and subject to the stipulations and conditions hereinafter appearing.

NOW THIS INDENTURE WITNESSETH, &c.

[Here follows an interpreting clause—1. defining, among other things, a telephone as an instrument used for transmitting or receiving spoken messages by means of electricity.]

License to Company to carry on Telephone Business.—2. The Company shall during the term of 31 years commencing on or as from the 1st day of January, One thousand eight hundred and eighty-one (determinable nevertheless as in this Indenture provided), have license and permission from the Postmaster-General (subject as heieinafter provided) to work and use telegraphs of which the transmitting and receiving instruments shall be telephones, but no other kind or description of telegraphs, for the purpose of enabling any person with whom the Company agree in that behalf, to transmit, direct from, and receive at any office to and from any other person at any other office by means of spoken words (but not otherwise), and with the aid of such telegraphs as aforesaid, telegraphic messages relating to the business or private affairs of such persons respectively, or one of them; and the Company shall have license and permission to receive from all such persons as they shall agree with as aforesaid for or in respect of the purchase or hire or maintenance or working or use of the said telegraphs or any part or parts thereof for the purpose aforesaid or for or in respect of the right or permission to transmit or receive or otherwise in respect of the transmission or receipt of such telegraphic messages as aforesaid by means of the said telegraphs such sums of money or other valuable considerations as shall be agreed upon between the Company and the said persons respectively PROVIDED ALWAYS that the term "business" used in these presents shall not be construed or held to mean or include the business of collecting receiving or delivering messages or other communications transmitted or intended for transmission by telegraph or any other business of a like kind.

Clause 3 forbids the transmission and receipt of written messages.

Clause 4 forbids the collection or delivery of telephone messages.

Clause 5 makes provision for the breach of these conditions.

Unlicensed Telegraphs not to be used for Company's Business.—6. The company shall not at any time use, or permit or suffer to be used for any of the purposes of these presents, or any of the licenses, powers, or authorities hereby granted, any telegraph of the kind or description hereby licensed, or any part of any such telegraph which has been supplied to, or has come into the possession of any person otherwise than by purchase, hire, or loan from the company, or in respect of which, or of the purchase or hire, or maintenance, or working, or user, or right of user of, or permission to use which any money or other valuable consideration has been given or agreed to be given to the company before such telegraph, or part of such telegraph, as aforesaid, was telegraphically connected with the aforesaid telegraphs of the company, or has been given or agreed to be given to any person other than the company either before or after the execution of these presents unless, and until the company shall have given notice in writing to the Postmaster-General of their desire to use such

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telegraph, or part of such telegraph, as aforesaid, three clear days at least before the user thereof, and until such notice has been given no such telegraph or part of such telegraph, shall be deemed to be within the license and permission granted by these presents, and from and after the expiration of such notice, the company may work and use such telegraph or part of such telegraph as aforesaid, in the same manner as any other telegraph or part of any telegraph hereby licensed, subject on the part of the company to the payment of the royalty hereinafter mentioned in respect thereof, and to the observance and performance of the several covenants and conditions herein contained affecting the same.

Royalties.—7. In addition to all other moneys which may become payable to the Postmaster-General under these presents, the company shall pay to the Postmaster-General the following moneys hereinafter called royalties (that is to say)—

(1) The company shall pay to the Postmaster-General a royalty equal to 10 per cent. of the gross amount of every sum of money paid or payable by any person to or on behalf of the company, for or in respect of the purchase, or hire, or maintenance, or working, or user, or right of user of, or permission to use any telegraph or telegraphs of the kind or description hereby licensed, or any part or parts of such telegraph or telegraphs or for, or in respect of the user, or right of user of, or permission to use any office or part of an office occupied by the Company or otherwise in respect of telegraphic messages transmitted by means of any such telegraph or telegraphs, or otherwise howsoever in relation to any such telegraph or telegraphs, or any part or parts thereof, and whether such sum of money be a gross sum or be payable periodically or by instalments, and every such royalty shall become due so soon as the sum of money in respect of which it is payable or by the amount of which it is regulated shall be paid or shall, by virtue of any express or implied contract or otherwise, be payable whichever event shall first happen.

(2.) In case any person should give to or confer upon the Company any valuable consideration or benefit (not being money or a contract solely for the payment of money) for, or in respect of, the purchase, or hire, or maintenance, or working, or user, or right of user of, or permission to use, any such telegraph or telegraphs, or any part or parts thereof, or for or in respect of the user, or right of user of, or permission to use, any office or part of any office occupied by the Company either solely or jointly or otherwise in respect of telegraphic messages transmitted or received by means of any such telegraph or telegraphs or otherwise howsoever in relation to any such telegraph or telegraphs, or any part or parts thereof, the Company shall pay to the Postmaster-General a royalty equal to 10 per cent. of the value in money of such consideration or benefit, and for the purpose of estimating the amount of such last-mentioned royalty the value in money of such consideration or benefit shall be determined by the certificate of such officer of the Post Office as the Postmaster-General shall appoint for that purpose, or in case of dispute by arbitration as hereinafter provided, and such royalty shall be payable and paid at such time or times and by such instalments and generally in such manner as the Postmaster-General shall appoint, and shall be payable in addition to such royalty or royalties (if any) as shall be payable in respect of such person under the stipulations hereinbefore contained.

(3.) In case any sum of money be paid, or payable to, or other valuable consideration or benefit be given to or conferred upon the company by any person or persons for, or in respect of the purchase, or hire or maintenance, or working or user, or right of user of, or permission to use any telegraph maintained or used solely for the transmission of telegrams which are by law excepted from the exclusive privileges of the Postmaster-General (hereinafter for brevity styled a "private telegraph") in addition to any sum of money paid or payable or other valuable consideration given to or conferred upon the company by the same person or persons for or in respect of the purchase or hire or maintenance or working or user or right of user of or permission to use any telegraph of the kind or description hereby licensed the Postmaster-General may at his option apportion such sums or other valuable considerations respectively either in whole or in part between the said private telegraph and such other telegraph as aforesaid in such manner or in such proportions as he may deem fit and proper, and thereupon such sums or other valuable considerations respectively as he shall apportion accordingly shall as between the company and the Postmaster-General for the purposes of these presents be deemed to be the sums or valuable considerations respectively paid or given by such persons as aforesaid in relation to such private telegraph and such other telegraph as aforesaid respectively in lieu of the sums or valuable considerations actually paid or given by such persons in relation to such telegraphs respectively.

(4.) In case the Company should, as hereinbefore provided, use or permit suffer to be used for any of the purposes of these presents, or any of the licenses, powers, or authorities hereby granted, any telegraph of the kind or description hereby licensed, or any part of any such telegraph which has been supplied to, or has come into the possession of, any person otherwise than by purchase, hire, or loan from the Company, or in respect of which, or of the purchase, or hire, or maintenance, or working, or user, or right of user of, or permission to use which any money or other valuable consideration has been given or agreed to be given to the Company before such telegraph or part of such telegraph as aforesaid was telegraphically connected with the aforesaid telegraphs of the Company, or has been given or agreed to be given to any person other than the Company either before or after the execution of these presents, the Company shall pay to the Postmaster-General such a royalty in respect thereof as under all the circumstances of the case shall be fair and reasonable, and the amount thereof shall be determined by the certificate of such officer of the Post-office as the Postmaster-General shall appoint for that purpose, or in case of dispute by arbitration, as hereinafter provided, and shall be payable and paid at such time or times, and by such instalment and generally in such manner as the Postmaster-General shall appoint

(5.) Nothing herein contained shall entitle the Postmaster-General to receive any royalties from the company on any money or other valuable consideration received by the company on the sale of any telegraph or telegraphs which the company after such sale do not work or use under this license, it being the intention of these presents that all royalties payable to the Postmaster-General in respect of any such telegraph or telegraphs shall be paid by the person working or using the same, provided always that the company shall seven days at least before any such sale of any such telegraph or telegraphs as last aforesaid deliver a notice in writing of such intended sale at the General Post Office in London, and such notice shall contain the name, address, and occupation of the intended purchaser or purchasers of such telegraph or telegraphs, and also full particulars of the offices intended to be connected by means thereof.

Clauses 8 and 9 deal with the accounts which are to be kept by the companies and furnished to the Postmaster-General quarterly.

Payments to be made Quarterly.—10. The Company shall pay to the Postmaster-General within six weeks after the 31st day of March, the 30th day of June, the 30th day of September, and the 31st day of December in every year the amount or amounts which shall be due to the Postmaster-General in respect of the preceding quarter of a year.

Power to Postmaster-General to inspect Telegraphs at all offices.—11. The Postmaster-General and his engineers and agents may from time to time, and at all reasonable times enter upon all or any office or offices in the possession or occupation of the company either solely or jointly with any other person or persons respectively for the purpose of inspecting and may inspect the telephones and other telegraphic instruments and appliances fixed or being in such places respectively, and the working and user of such telegraphs respectively, and the company shall from time to time upon the request of the Postmaster-General procure from any person permitted by them to use the said telegraphs at any other office or offices which may be occupied by them either solely or jointly with any other person, his consent to such entry and inspection so far as regards such office or offices of such person and the telephones and other telegraphic instruments and appliances fixed or being in such office or offices.

License not to be assigned.—12. The company shall not assign, underlet, or otherwise dispose of the powers or authorities hereby granted or any of such powers or authorities without the consent in writing of the Postmaster-General.

Company's Telegraphs not to interfere with Postal Telegraphs.—13. All telegraph posts, wires, and telegraphic appliances used or intended to be used as part of or in connection with the telegraphs of the company, shall be so erected, fixed, placed, and used as not either directly or by reason of the working or user thereof to interfere with the efficient or convenient maintenance, working, or user of any telegraph posts, wires, or telegraphic appliances of the Postmaster-General, which may from time to time exist, or which it is probable that the Postmaster-General may have occasion to erect, place, fix, or use, or to expose any such posts, wires, or appliances to risk of damage, or to risk of interference with the efficient or convenient working or user thereof.

Removal of Injurious Telegraphs.—14. In case any telegraph post, wire, or telegraphic appliance used or intended to be used as part of or in connection with the telegraphs of the company, or the working or user of any such post, wire, or appliance shall, in the opinion of the Engineer-in-Chief for the time being of the Post Office, certified by writing under his hand, directly or indirectly damage or interfere with the efficient or convenient maintenance, working, or user of any telegraph post wire or telegraphic appliance of the Postmaster-General for the time being existing, or expose any such post, wire, or appliance to risk of damage or to risk of interference with the efficient or convenient working or user thereof, the Company shall, within 24 hours after service on them of a notice in writing by the Postmaster-General, complaining of such damage or interference or apprehended damage or interference, either remove the post or posts, wire or wires, or telegraphic appliance or appliances complained of in such notice, or refix, alter, or repair the same to the satisfaction of the engineer-in-chief for the time being of the Post Office, and if the Company shall make default in so doing within the time aforesaid it shall be lawful for the Postmaster General to remove, alter, or repair the post or posts, wire or wires, or telegraphic appliance or appliances complained of in such notice, and the Company shall, on demand, pay to the Postmaster-General the cost of any removal, alteration, or repair by the Postmaster-General of the posts, wires, and telegraphic appliances complained of in such notice or any of them.

Clause 15 requires the company to pay for any damage done by their wires or appliances to the property of the Postmaster-General.

Provisions for Determination of License on Breach of Contract.—16. In case any sum of money which ought to be paid by the company to the Postmaster-General under or by virtue of these presents shall be in arrear and unpaid for one calendar month after the time at which the same ought to be paid under or by virtue of the covenants herein contained, or in case of any breach, non-observance, or non-performance by or on the part of the company of any of the covenants (other than a covenant for the payment of money) or conditions herein contained, and on the part of the company to be observed and performed, then, and in any such case, the Postmaster-General may, by writing under his seal, revoke and determine the licenses, powers, and authorities hereinbefore granted, and each and every of them, and thereupon the said licenses, powers, and authorities, and each and every of them shall absolutely cease, determine, and become void. Provided always that no such revocation or determination as afore-

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said shall prejudice or affect any right of action or remedy which shall have accrued, or shall thereafter accrue, to either of the parties hereto under the covenants herein contained.

Power to Postmaster-General to purchase Company's Telegraphs.—17. The Postmaster-General may at any time by six calendar months' previous notice in writing, terminating on the 31st day of December, 1890, or on the 31st day of December, 1897, or on the 31st day of December, 1904, signify to the company his intention to purchase the business of the company; with respect to which this agreement is entered into, and if any such notice be given, the company shall sell and convey, and the Postmaster-General shall purchase all the telegraphs of the company worked under the provisions of these presents, and all the rights, powers, privileges, works, and other property of the company appurtenant to or forming part of such business, and the particulars of the property to be comprised in and the price to be paid by the Postmaster-General for such purchase shall, in case of difference, be determined by arbitration as hereinafter provided.

Arbitration.—18. All matters which in pursuance of the stipulations hereinbefore contained are to be determined by arbitration shall be referred to and determined by the award or awards of a single arbitrator, pursuant to and so as with regard to the mode and consequences of the reference and in all other respects to conform to the provisions of the common Law Procedure Act, 1854, or any then subsisting statutory modification or re-enactment thereof for the time being in force, and the arbitrator on any such reference shall have power to examine witnesses upon oath or affirmation or otherwise, and either to fix, settle, and determine the amount of costs and expenses of and incidental to the reference and award to be paid by both parties or by either party, or to direct the same to be taxed as between solicitor and client or otherwise, or to be settled by any other person or persons, and to direct and award when and by and to whom such costs and expenses respectively shall be paid, and these presents shall be deemed to be a submission to arbitration within the last-mentioned Act, or any such modification or re-enactment thereof as aforesaid, and may upon the application of either party to any reference thereunder and without notice to the other of them to be made by a rule or order of any division of Her Majesty's High Court of Justice.

Agreement not to Affect Postmaster-General's Rights.—19. Nothing in these presents contained shall prejudice or affect the right of the Postmaster-General from time to time to establish, extend, maintain, and work any system or systems of telegraphic communication (whether of a like nature to the aforesaid business of the company or otherwise) in such manner as he shall in his discretion think fit, neither shall anything herein contained prejudice or affect the right of the Postmaster-General from time to time to enter into agreements for, or to grant licenses relative to, the working and user of telegraphs (whether of a like nature to those worked and used by the company or otherwise) or the transmission of telegrams in any part of the United Kingdom with or to any company, person, or persons whomsoever upon such terms as he shall in his discretion think fit. And nothing herein contained shall be deemed to authorise the company to exercise any of the powers or authorities conferred on or acquired by the Postmaster-General by or under the Telegraph Acts, or any of them.

The remaining clauses are merely formal.

LABORATORY NOTES ON ALTERNATING-CURRENT CIRCUITS.*

BY PROFS. W. E. AYRTON, F.R.S., AND JOHN PERRY, F.R.S.

(Concluded from page 195.)

A Shunt Transformer.

The following problem presented itself to our student, Mr. Smith, whose name we have just mentioned; and as his solution depends on the lag produced by self-induction, we have thought that this may be a fitting opportunity for bringing the matter forward. The problem is as follows:—If a certain alternate potential difference be maintained between two mains, M M (Fig. 2), between which there are two incandescent lamps, P and Q, is it possible to make the sum of the mean potential differences maintained at the terminals of the lamps greater than the mean potential difference maintained between the mains without disconnecting the lamps from the mains and inserting an ordinary transformer? For example, suppose that the mean potential difference between the lamps be 100 volts, and it requires a mean potential difference of 55 volts to be maintained between the terminals of each lamp to make it glow properly, can this result be attained without disconnecting the lamps from the mains?

Let 1 1 1 1 (Fig. 3) represent the curve of impressed potential difference; then this may be regarded as being composed of two coincident curves, 1 2, 1 2, the ordinates of which are each exactly half the corresponding ordinates of the original curve 1 1 1 1. Now let it be possible to retard one of the smaller curves and accelerate the other so that they take some position like 3 3 3 3 and 4 4 4 4 (Fig. 4); then, since the sum of the corresponding ordinates of these two curves is equal to the corresponding ordinates of the original curve, it follows that *the mean value of the ordinates of each of these curves must be greater than half the mean value of the ordinates of the original curve.* Mr. Smith's view was, if one of the lamps, P, were shunted with a high resistance possessing much self-induction (Fig. 5), and the other lamp, Q, with a non-inductive high resistance, the wave of potential difference at the terminals of P would be accelerated, while that at the terminals of Q would be retarded, as shown in Fig. 4; hence the result would be that the brightness of the two lamps would be increased by the application of the high-resistance inductive shunt and the high-resistance non-inductive shunt—a result which experiment shows to be correct.

It will probably be objected to this solution that it cannot be employed without introducing a large waste of power, and therefore can have no practical value. But exactly the same objection was raised some years ago to the employment of the ordinary transformer. And just as the practical importance of using transformers has led to such improvements being made in them that the waste of power introduced by their use is far more than compensated for by the economy they introduce into electric distribution, so in the same way is it not possible that Mr. Smith's solution may be so improved that the gain in power arising from working incandescent lamps at their best efficiency may more than compensate for the loss of power in his "shunt transformer"?

On the Effect of Self-Induction in Destroying Ripples.

In the discussion on Mr. Kapp's paper, and on former occasions, we have described to the Society the effect of self-induction in causing the current in an alternating-current circuit to become more and more a sine function of the time. We assumed, of course, that there was a fixed self-induction of the circuit, and we were not considering the possibility of the presence of iron making the self-induction vary, as we know that it does. We have stated that the minor ripples or harmonics never wholly disappear.

We must refer our readers to the *Journal* of the Institution for the elaborate mathematical investigation which follows. The result arrived at is that "hence if the E.M.F. does not follow truly a sine function of the time, the current, although it may be made more nearly a sine function of the time, cannot truly become so, however great the self-induction may be." As an example a case is taken which is "probably the most discontinuous periodic function which we can imagine as occurring in practice. That is, let us imagine the E.M.F. at time O, to have suddenly increased from $-V$ to $+V$,

At time $t=\frac{T}{2}$ to suddenly diminish from V to $+V$.

At time $t=T$ to suddenly diminish from $-V$ to $+V$,

and so on, remaining constant except at times O, $\frac{T}{2}$, T, $\frac{3T}{2}$, 2 T, &c."

It is then shown that "as $\frac{L}{Tr}$ gets greater and greater the current tends more and more to follow the law indicated by the curve—or, rather, straight line—shown in Fig. 6; and this is the nearest approach to a sine function which the current can attain to with such a discontinuous E.M.F. as we have taken."

We give another rather discontinuous periodic function as an example. We assume that the E.M.F. varies in the way shown on Fig. 6.

We have drawn the curves representing C for the values of $\frac{L}{Tr}=0$, 0·01, and 0·1 in Fig. 7, the distance A E representing T, the periodic time.

A B C D E shows current when $\frac{L}{Tr}=0$;

A′ B′ C′ D′ E′ ,, ,, ,, $\frac{L}{Tr}=\cdot1$;

A″ B″ C″ D″ E″ ,, ,, ,, $\frac{L}{Tr}=1$.

The ordinates of this last curve (for $\frac{L}{Tr}=1$) have been magnified ten times.

It is evident that even when E is such a very discontinuous function as this, a moderate amount of self-induction makes the current what is very nearly a pure sine function of the time.

Electric Frequency Meter.

Some time ago one of us suggested, during a discussion on transformers, that a method might be used for analysing an alternate-current wave which somewhat resembled the employment of Helmholtz's resonators for analysing a complex sound vibration. The method then proposed consisted in sending through one of the coils of a dynamometer the current to be analysed, and through the

* Extract from the *Journal* of the Institution of Electrical Engineers, Part 79, Vol. XVIII.

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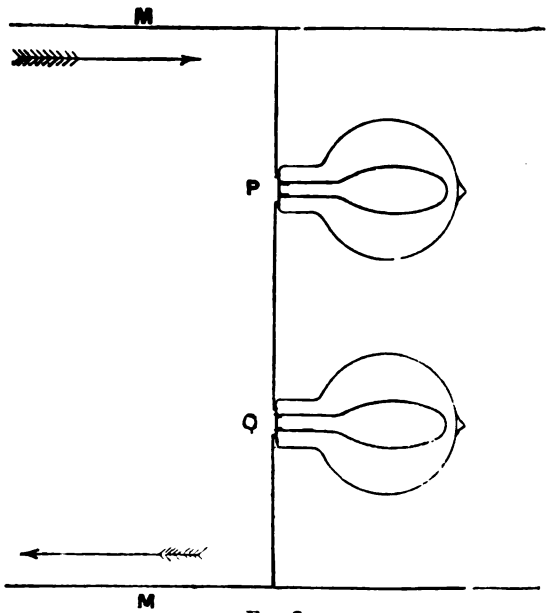

FIG. 2.

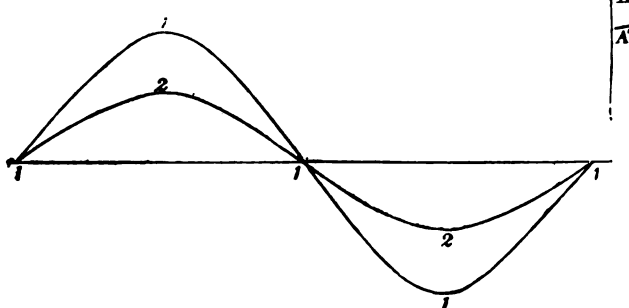

FIG. 3.

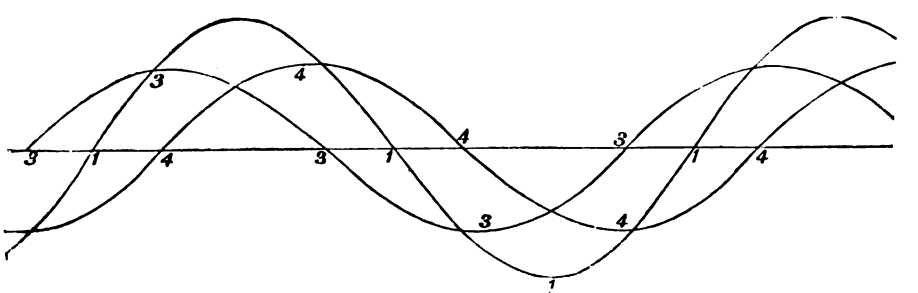

FIG. 4.

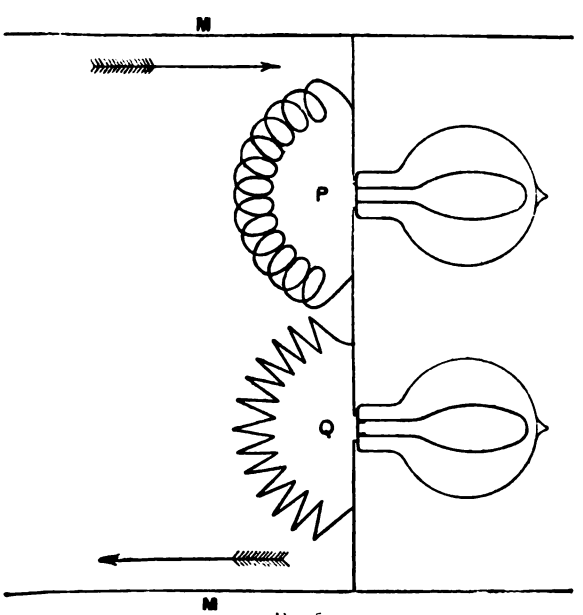

FIG. 5.

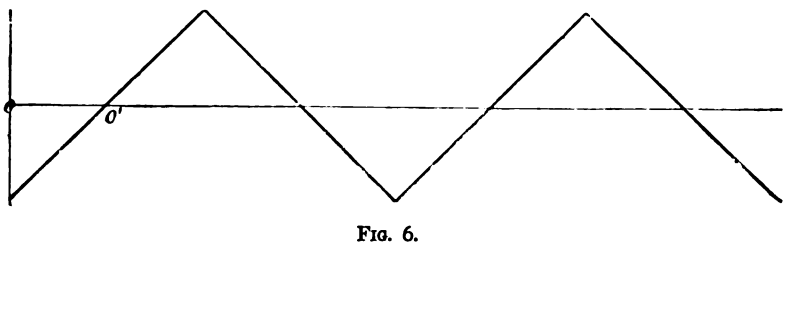

FIG. 6.

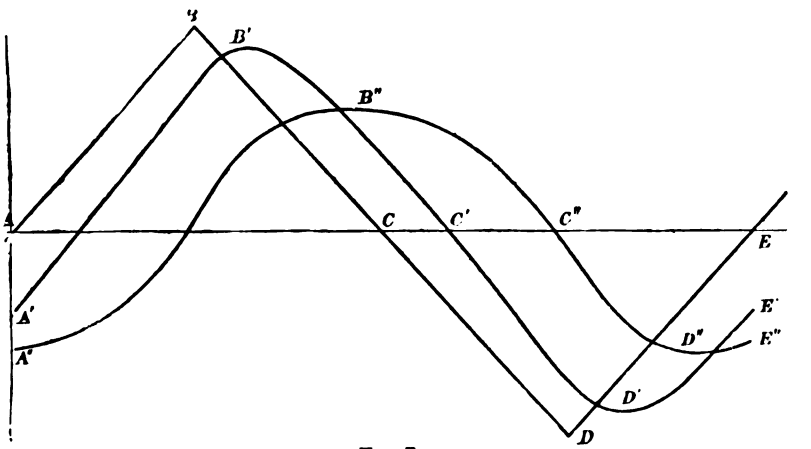

FIG. 7.

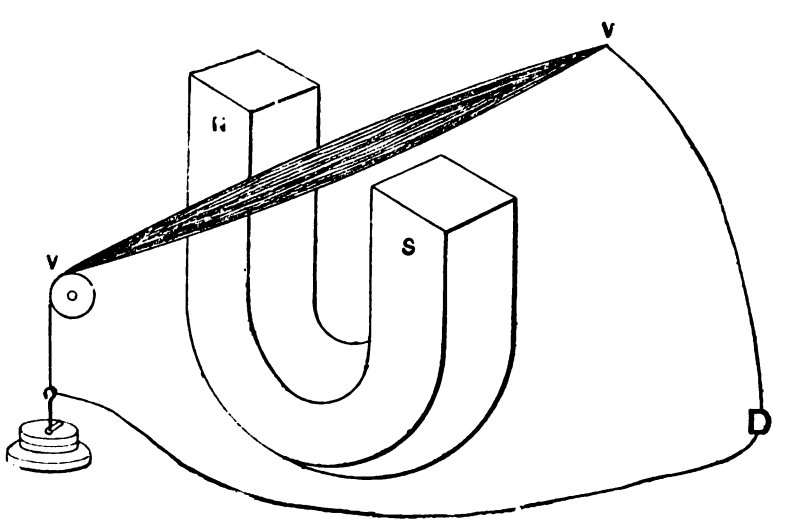

FIG. 8.

N S, magnet producing permanent field. *V V*, wire conveying alternate current, and tuned so that its natural period of vibration agrees with that of the alternate current. *D*, alternate-current dynamo.

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other an alternate current of known frequency, and varying the frequency of the test current until an attraction was observed between the two coils. The smallest frequency of the test current that will produce such an attraction gives the fundamental rate of alternation of the current which is being analysed, and the magnitude of the attraction between the two coils of the dynamometer the amplitude of the fundamental rate of alternation. The frequency of the test current is then gradually increased until an attraction is again observed between the dynamometer coils, from which the frequency and amplitude of the first higher rate of alternation is determined, and so on for all the component vibrations.

This method has been used with a certain amount of success by Messrs. Lamb and E. W. Smith, at the Central Institution, for the analysis of the current produced by the Ferranti machine. Previous experiments had shown us that this current was not a simple sine function of the time, as the curve rises less rapidly and falls less rapidly than a true sine curve. The difference, however, between the two is not very great, and the unimportance of the harmonics compared with the fundamental rate of vibration in the current curve of the Ferranti machine renders the analysis of this current a severe test of the method, which, however, was sufficiently sensitive to show that the Ferranti current-wave consists of a fundamental rate of alternation, no appreciable components either for twice or three times the fundamental rate of alternation, but sensible components having respectively four and five times the rate of alternation of the fundamental; that is, the alternation is made up of a fundamental and the third and fourth harmonic.

Quite recently two of our students—Messrs. Healing and Le Tall—have been experimenting on another resonance method of analysing an alternate-current vibration which we have suggested to them, and, considering how rough is the apparatus they have been using, and how short a time they have been engaged on this new method, the results are unexpectedly satisfactory, and appear to show that this method, which is extremely simple, is one of great promise. The alternate current to be analysed is passed through a stretched wire, V V (Fig. 8), the length or tension of which can be varied as in a monochord. This wire is in a magnetic field produced by a permanent magnet, N S, or by an electromagnet, or, best of all, by a coil of wire surrounding the wire V V as a flat galvanometer coil surrounds the needle. As the current in the wire alternates the wire receives impulses backwards and forwards across the lines of force produced by the magnetic field, and if the length and tension of the wire be adjusted by trial until the natural time of vibration of the wire agrees with the periodic time of variation of the alternate-current, the wire oscillates vigorously with an amplitude from 1½ to 2in., emitting, of course, a musical note. The sudden way in which the wire starts vibrating when its length and tension are just right is very striking. The frequency can be determined from the musical note emitted by the wire; but as that would require tuning-forks or some other apparatus having fixed rates of vibration, as well as a musical ear, we prefer to determine the frequency by using the well-known formula for a vibrating string, viz.,

$$n=\frac{1}{2l}\sqrt{\frac{t}{m}},$$

where n is the frequency, l the length of the wire in centimetres, t the tension in dynes, and m the mass in grammes per centimetre of the wire.

In the first experiments we commenced with the wire comparatively slack, and on gradually tightening it up it was seen to vibrate very slowly. Holding one's finger on the wire and counting the vibrations, they were found to correspond with the speed of the engine driving the alternate-current dynamo D, which was sending the alternate-current through the wire. On tightening up the wire a little more it responded to twice this rate of vibration, which may, perhaps, have corresponded with the number of piston strokes; then the wire required a good deal of tightening, when it suddenly burst into vibration, and on calculating the value of n from the formula just given, a result was obtained closely agreeing with the electric frequency, which, with the particular dynamo employed was eight times the number of rotations of the armature per second. On tightening the wire still more, shriller notes were heard, and smaller waves seen superadded on the fundamental vibration of the wire as a whole. We were at first afraid that the analysis of the harmonics of the alternate current would be troubled by the vibrating wire having harmonics of its own, but we were reminded by Mr. Lamb of the well-known fact—which we ought to have remembered—that the harmonics possessed by the vibrating string of a musical instrument are impressed on it in the act of setting the string in vibration, or, in other words, that a string has no harmonics of its own. Hence we may safely conclude that the higher rates of vibration seen and heard with our wire are really due to harmonics in the alternate-current wave itself. To determine the frequency and amplitude of each of these harmonics the length and tension of the wire are adjusted until its natural period of vibration agrees with the particular harmonic sought for in the alternate-current, and which agreement is evidenced by the wire vibrating vigorously when it is attained.

We have not yet gone beyond this point in our experiments, but some modifications and developments of the method that have occurred to us may be briefly referred to. Instead of tuning the wire to accord successively with each of the harmonics sought for, it may be found convenient to have a number of wires tuned to give out, and therefore to respond to, different notes, as in a harp, and placed in a magnetic field, then to send the alternate-current to be analysed through them in parallel or in series (probably the latter would be better), and observe which of the wires vibrate, and what are the various amplitudes of vibration. Or, instead of sending the alternate-current through the stretched wire or wires, it may be sent round a solenoid or electro-magnet, and a direct current sent through the stretched wire or wires, placed relatively to the solenoid so that a current in the wire or wires is deflected by a current passing round the solenoid. Or, in place of a vibrating wire, a magnetic tongue the natural rate of vibration of which can be varied by altering its length or its moment of inertia, or in some other convenient way, may be placed near a solenoid or electro-magnet round which flows an alternate current. Or a set of such tongues tuned like the vibrating springs of a mouth-organ may be employed to analyse an alternate current sent round a solenoid or electro-magnet.

In the figure the alternate-current dynamo is shown near the vibrating wire, but it will be obvious that any one of these arrangements may be employed to measure the frequency of an alternate current at *any distance* from the dynamo. Or they may be used simply to measure the speed of the dynamo at any point of the circuit through which flows the alternate current produced by the dynamo if the number of alternations per revolution—which is, of course, a definite number for each dynamo—be known. Or, generally, if there be attached to any moving mechanism some arrangement for making and breaking a current, or varying the strength of a current, any one of these methods may be used at any distance from the moving mechanism to measure the frequency, and, therefore, the speed at which the mechanism is moving, so that the arrangement can be used as a simple speed-indicator for indicating at a distance the speed of moving machinery.

If the vibrating wire consist of two or more wires mechanically joined together, but electrically insulated from one another so that different currents can be passed through them, then, if the currents be of the same frequency, we can use our method for comparing the mean value of the algebraic sum of the currents with the mean value of any one of them; and by comparing the mean value thus found of the algebraic sum of two currents with what the mean value would be were there no difference in phase, we can determine this difference in phase. And the same thing may be done by sending the currents round different wires on a solenoid placed so as to cause a magnetic tongue to vibrate.

In fact, we have ourselves hardly yet realised all the uses to which this "electric frequency meter" can be put.

LEGAL INTELLIGENCE.

United Telephone Company v. Ahern and Company.

An action of the United Telephone Company (Limited) *v.* Ahern and Co., came before Justice Kay on Saturday, 29th ult., as a short cause, the defendants not having appeared.

Mr. MICKLEM appeared for the plaintiffs, and said the action was brought on two patents, the Edison and Bell, and the statement of claim stated that the validity of these two patents had come in question in a previous action, and had been established, and certificates granted. With the statement of claim had been delivered particulars of breaches, setting out the various acts of which the plaintiffs complained, and the order asked for was that the defendants might be restrained from manufacturing, selling, supplying, or using any of the telephone transmitters mentioned in the particulars of breaches, or any other instruments constructed according to the specification named.

Justice KAY said he could not grant the injunction in that form, the defendants not appearing. He did not think the particulars of breaches formed part of the pleadings, and, therefore, he could only grant an injunction restraining the defendants from infringing the patents mentioned in the statement of claim.

Mr. MICKLEM said the minutes further asked an order that the defendants do within seven days from service of the order deliver up on oath all infringing instruments in their possession or under their control, for an inquiry as to damages, and an order that the defendants pay such damages within 14 days after certificate, and all costs, charges and expenses as between solicitor and client, according to section 31 of the Patent Act of 1883.

His LORDSHIP made the order in this form

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The Electrician.

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THE TELEPHONE COMPANIES' LICENSE.

For the better understanding of some of the points in dispute between the Telephone Companies and the Post Office we this week publish the chief clauses of the License under which the companies carry on their business. We do not know that the document has ever been made public before; but if it has, several of its leading features appear to have been forgotten by writers who have recently commented on the situation. As to the proposed amalgamation, clause 12 would seem to preclude that operation (supposing a transfer or assignment of *the powers or authorities* conferred by the License were contemplated) except with the sanction of the POSTMASTER-GENERAL. Probably this is not disputed; but it is argued that he ought to give his sanction because the amalgamation has been contemplated from the first, Clause 7 and sub-sections providing for such a contingency. That clause may be open to legal argument; but from a layman's point of view it strikes one as being—what the POSTMASTER-GENERAL has described it—a provision for enabling licensed companies to part with or acquire portions of other systems without rendering the vendors liable

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for the royalty on the business disposed of. In other words, subdivision, not amalgamation, seems to be here contemplated. As to the bearings of Clause 12 on the actual circumstances we shall say something presently.

The preamble to the License contains a very explicit declaration as to the rights of the Post Office in the Telephone as a Telegraph, and to this proposition the signatories may be said to have assented once and for all. But besides this, there is a very noteworthy passage in Clause 19 which carefully guards against the assumption that in obtaining the concessions under the License the companies acquire any of the rights granted by Parliament to the Post Office. A perusal of this clause reveals one of the reasons which probably actuates the POSTMASTER-GENERAL in opposing the growth of a virtual monopoly in telephony similar to the actual and legal one possessed by the Post Office. It may be conjectured, however, that this is not his chief reason, which is a little more closely related to the pockets of the Treasury than to the convenience of the public. The question of State purchase has in fact—whether intentionally or not we do not pretend to say—been forced prominently forward by this project of amalgamation on the part of the United and its subsidiary Companies; and apparently the POSTMASTER-GENERAL is only awaiting a decisive expression of public opinion to determine his course of action next year. Several journals have frankly advocated a transfer of the whole Telephone service to Government control; others are ostensibly opposed to it, but apparently on no better grounds than that the Telegraphs have not prospered in Government hands! We reserve our own opinion for the present; but if no better argument than this can be brought against State purchase, the days of the Telephone Companies are numbered.

We have said that Clause 12 is explicit with regard to the assignment or sale of the powers or authorities conferred by the License. But the companies' contention, as we understand it, is that no such assignment is intended or necessary, the only operation involved in the present project being the transfer of business and plant, a transaction which the POSTMASTER-GENERAL has no authority to prevent under the License. In other words, the companies can assign and unite their businesses, although they may not assign their Licenses; and seeing that each of the companies possess a License covering the whole country, the License of any one of these companies will suffice, without meddling with any of the others, which presumably would be simply allowed to lapse. For example, with regard to the particular scheme now under consideration, a journal which claims to represent the Telephone Companies puts the case in a nutshell: "The License granted to the NATIONAL TELEPHONE COMPANY covers the whole country, and no legal sentence could prevent this Company from carrying on their business after having purchased the business of the two other Companies." It will now be understood why the UNITED COMPANY in its letter to the Post Office of 14th June argued the point exclusively on the right of a Joint Stock Company to transfer its business as it may deem fit, and made no reference to the Post Office License which, from the Company's point of view, reserves only the right to prevent the assignment of those "powers or authorities" which are granted by the Post Office.

And we can now also appreciate the POSTMASTER-GENERAL'S hesitation in pronouncing a legal opinion on the interpretation of the clause. Unless there exists some other condition which we have overlooked outside of Clause 12, it seems to us that there is nothing in it to prevent the National Company doing what they propose to do, and that they will only be deterred from doing it by the covert threat of the POSTMASTER-GENERAL to avail himself of the purchase clause (17) next year. Of course the point is a technical one on both sides, and we suppose that the companies will not deny that they are straining it to its utmost, as indeed they have a right to do. On the side of the Post Office it will now be seen that in guarding against one danger at the outset they have incurred another of greater magnitude later on. If the licenses had covered only certain limited and defined areas, obviously the licensees could not have united unless with the POSTMASTER-GENERAL'S consent; but seeing that the powers of the licenses are not so restricted, any one of the licensees can absorb the whole country's business without consulting him. The upshot is somewhat startling, and is plainly not what the Post Office intended; but the case thus presented by the companies is a very plausible one, and unless Mr. RAIKES has some counterblast in reserve he will have to either allow the amalgamation to proceed without further unavailing protest, or take into serious consideration the invitation of the journal already quoted, and "buy up the telephone companies next year." At the meetings of the two principal companies held yesterday the resolutions authorising the amalgamation were fully confirmed. As will be seen by our Parliamentary intelligence, the subject occupied the attention of the House of Lords last night.

PROBLEMS IN ELECTRIC TRACTION.*

BY DR. LOUIS BELL.

The preliminary stage of electric tramways is to-day quite gone by. While three years ago such an application of electricity was regarded very dubiously, that doubt is now displaced by the certainty that the electric road is a success and has come to stay. The live question to-day does not involve the chances of the electric road but the chances of its competitors. There are now something like fifty electric roads in regular daily operation in the United States, covering about two hundred miles of track, employing all sorts of systems, working under all manner of adverse conditions, climbing grades of pitch equivalent to four and five hundred feet to the mile, taking curves of all possible radii, and there has been with all this no report of failure anywhere. On very many of these roads electricity has replaced horses, and nearly every week brings reports of similar substitutions elsewhere. No inroads have as yet been made on the cable systems, but it is an open question whether they can hold their own, even in the favourable localities where they are already established. No one need ask, in face of these facts, whether electric traction is practicable or successful, but rather such questions as these: How efficient is it? What is its first cost, compared with horse or cable traction? How do its running expenses and repairs compare with these? What grades and curves can safely and economically be taken? What accidents is it liable to, and how can they be prevented? What are the conditions of efficient and economical running?

It was for the purpose of attempting to answer some of these vital questions that the present investigation has been carried on. To obtain thoroughly practical results applicable to the everyday working of an electric tramway I have not concerned myself with theoretical motor tests and curves, but have confined myself quite closely to actual car tests of power and efficiency and to the evidence of the ammeter and the indicator diagram at the power station. The man who contemplates putting his money into an electric road does not particularly care about the characteristic of the motor used, but he does want to know how much power must be developed on his cars, how much coal he must burn at the power station to obtain it, what efficiency he may expect from the system, what are its weak points, and how they may be strengthened.

Through the kindness of Mr. Hawter, superintendent of the La Fayette (Ind.) Street Railway, every facility has been afforded me for making a thorough and detailed test of the road, and such of the results as may properly be published are recorded in this paper, only such details as directly concern the private business of the company being omitted.

Before taking up or discussing these experimental results, I purpose considering the general conditions under which electric roads must operate, the general difficulties to be met with, and the relations of this method of rapid transit to those with which it has to compete. There are many requirements for street railway work which are not met with in any other kind of traction. For

* From the *Electrical World* of New York.

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most of these the electric motor is admirably adapted, while for a few it is not. Consider, then, the conditions to be met in street railway work and the properties that a motor of any kind must have to be thoroughly suited to these conditions.

1. To meet public convenience a tramway line must in nearly every case run through the most frequented business streets of a town, and outside the business portion must pass through, or very near to, the thickly populated residence streets and on to the larger suburbs. It, therefore, is generally not at liberty to pick out a route of the easiest grades and curves, but must be able to surmount quite severe grades readily, and take without much danger of derailment any curves that the streets require, sometimes of radii barely above twenty feet.

2. It should be thoroughly reliable, *i.e*, track and motor system should be so constructed that the system will be of very little danger, first, of a complete breakdown, interrupting travel throughout the line, and second, of local accidents sufficient to pile up cars at any particular point.

3. It should have a considerable flexibility in the matter of speed. In any line where the cars run on anything like a fixed schedule, as will always be the case in anything except the very largest lines, they must be able to make up lost time within reasonable limits in case of a trifling accident or unusually frequent stops. For this reason the maximum speed should be considerable.

4. It must be able to stop and start quickly and easily. Running through crowded streets and liable at any moment to find its tracks blocked, the only security against serious and frequent accident is in the ability to stop quickly, even when running at full speed. Easy and quick starting too is quite necessary, since so much of the running time is taken up in just this way.

5. Track and motor system should be of such a kind as will cause the minimum amount of obstruction to the streets and annoyance to the travelling public. For this reason the rails are very low and unobtrusive, consequently somewhat less secure. Since most of the traffic is and will continue to be carried on by means of horses, any system that renders it difficult or dangerous to drive in the same street is open to objection.

6. The motor system should be tolerably silent, and of such a kind as not to prove a nuisance to the streets through which it passes.

7. It must be so arranged as to meet readily the demands of an unusual crowd at some one point. It frequently happens that most of the cars of a system must be started under nearly full load within a few minutes. This is specially true of lines connecting with suburbs, where the traffic is likely to be very uneven.

With all this, any tramway system must be tolerably economical in operation, and its first cost must not be prohibitive.

These conditions cover most of the points in street railway work, although in special cases they may be considerably modified. To meet these requirements all sorts of devices have been brought out. Taking, then, the three systems in extensive use, viz., cable, horses, and electric traction, let us see wherein they do, or do not fulfil, the above conditions, specially seeking out the weak points and difficulties of the electric systems.

So far as grades are concerned, the cable system easily takes first rank, for its power of hill climbing is limited only by the power of the grip and the tensile strength of the cable. Of course such excessive grades are neither desirable nor economical, but now and then they are almost unavoidable. Sharp curves can, of course, be employed on a cable system, but with disastrous effect on the life of the cable and the efficiency of the system. The wear and tear on a cable with many curves is very severe.

With horses very steep grades are exceedingly objectionable, but by the aid of hill horses can be taken, except in slippery weather. At best horses are far inferior to the cable system for grade work, though a horse car can safely take a curve that nothing else can, for the horses tend to guide and pull around the head of the car while in any motor system there is a certain tendency to jump the track even in spite of guard rails.

With electric roads the case is quite different. The motor cars depend on adhesion alone for hill climbing, and beyond a certain point adhesion fails. In such a car, however, the whole weight of car and contents rests directly upon the driving wheels in most cases, and consequently theoretically the possible grade per cent. should be numerically equal to the coefficient of adhesion. This can hardly be estimated exactly except by experiment in a given case, and street car tracks are generally not carefully enough laid to give good results. The data obtainable, however, would assign something like 20 per cent. as the maximum practicable grade and the real limit probably lies below this. As to the evidence offered by actual experience under working conditions, it is certain that with proper care of the track grades as high as 400 feet per mile can be operated with entire success. This presupposes that the rails are kept in good order and clear of sleet and snow. With extra vigilance in this respect, aided now and then by a little sand, I think it would be feasible to take grades of 500 feet per mile if necessary. Above a 10 per cent. grade the case is rather precarious when we consider the effect of rough weather. Occasional grades of greater pitch may be taken if they are not too long and conditions are favourable. As to curves, the electric roads are practically unlimited, but curves on grade are particularly undesirable and in any case the speed should be reduced and the track well supplied with guard rails. Save on a steep grade there is no likelihood of trouble.

As regards reliability, one may divide the various systems into two general classes—those in which each car is an independent unit, and those where all the cars have a common source of power. The former class comprises horses and the electrical accumulator system; the latter, cables, and all other modifications of electric traction. All traction systems are liable to occasional local mishaps, but a general breakdown is very improbable in the first class, while in the second it is likely now and then to occur.

With the usual electrical systems a general stoppage, except in very rare cases, is due to a single cause, a serious short circuit at some point on the line. The wiring is usually arranged so that a broken wire, aside from the contact wire, causes no serious trouble, and even if the contact wire breaks, only a short section of track is thrown out of service. If a bad short circuit occurs, however, it may become necessary to shut down the entire line. But such an accident can be remedied almost as soon as the scene of it can be reached, and a broken wire is very easily mended. Electrical roads are, however, quite liable to minor accidents to single cars. Brushes will turn, trolleys will come off, gears will occasionally break, field coils will now and then burn out and local short circuits occur. Most of these mishaps can be soon remedied, and not a few of them averted by a vigilant system of car and line inspection. In fact, I think it would be quite safe to say that three-fourths of these local accidents can and should be prevented.

Great power of varying speed is one of the characteristic advantages of the electrical systems. The speed may range from four or five, to fifteen miles per hour at will, each car being separately driven and controlled. As the ordinary running speed is considerably below the maximum, trains can be made up quite readily, and the speed lowered very much in crowded streets without resorting to stops and starts. Horse cars possess something of the same flexibility, but their maximum speed is so low that with modern needs for rapid transit the horse car must eventually disappear. As is well known, cable roads work virtually at a fixed maximum speed and can only slow down by letting go the cable.

The same qualities that give an electric car a widely varying range of speed give it also the power of starting very smoothly and easily. In this respect it is decidedly superior to the cable cars, which, although they can be made to start with tolerable ease, usually do not. In addition, the electric car possesses an almost unique power of stopping suddenly in case of need. In a crowded street, it not infrequently happens that man or beast slips directly in front of a moving car. With horses or cable, many accidents have resulted. With the electric car, however, the cases would be exceedingly rare in which a prompt reversal of the motors would not avert such a result, for if there is need, an electric car at full speed may be stopped within its length. I have seen a horse fall on the track within a few feet of a car at ordinary speed, and the car brought to a standstill without touching him. A man has been knocked down by the dashboard and the car stopped before the wheels reached him. Of course such sudden stoppage is only attempted in case of dire necessity, but when that necessity comes it can be and is done.

So far as track is concerned, all tramway systems have about the same requirements. In the case of all motor cars of whatever kind there is more or less trouble from frightening horses, and, for a time at least, making the streets dangerous to drive upon. Every place in which a motor system has been started can show a record of a rather serious kind. It is certainly an important consideration. Horses, however, soon become used to motors, and the main difficulty is only temporary. But all overhead electric systems and all using the rail as a part of the circuit are especially likely to scare horses on account of the frequent flashes from trolley or rails, or blazing at the brushes.

As regards noise, electric and cable cars are at present not widely different. In the electric systems the incessant grinding of the cable all along the line is absent, but the noise of the gearing is often considerable, particularly after it becomes worn. At present gearing seems the most feasible method of reducing the speed of the motors, but except when new, it is far from silent. The noise, however, of either cable or electric cars is not so great as to constitute a valid objection to their use.

With a proper plant, any of the electric systems can handle traffic massed at one point in a way that leaves little to be desired.

Aside from the general conditions to be met, an electric road encounters certain difficulties quite peculiar to itself, some of

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them real, others rather to be classed as imaginary. In the first place there is a widespread popular delusion that the overhead wire in general use is exceedingly deadly, and that the track used as return circuit is scarcely less so. As a matter of fact, the maximum potential used in tramway work, 400-500 volts, cannot be classed as even dangerous. It would, of course, be decidedly unpleasant to receive the full effect, but there is no reason to believe that it would imperil life, or cause a more serious injury than burns at the point of contact. In fact, a large number of *employés* of electric roads have received the full E.M.F. without injury. In addition the wire is carried so far out of reach that the public cannot get at it, and even if it falls it is soon got out of the way. The track return is perfectly harmless. These facts are well known wherever an electric road has been in operation for any length of time.

It is, nevertheless, quite clear that the overhead system must be abandoned in large cities, except in some few special cases. Eventually all wires must and will go underground in such situations, and electric tramways, like electric lighting systems, must face the difficulty. That this difficulty is a real one no one who has watched the progress of underground work will care to deny, but the ostentatious collapse of certain electricians under the weight of the problem is hardly in keeping with the skill and readiness they have heretofore displayed. Fortunately the case for tramways can be easily solved, either by a conduit or storage batteries. Which of the two will furnish the ultimate solution of the problem depends mainly on the progress made in accumulators within the next few years. Could the accumulator be reduced to a reasonable weight, it would certainly furnish the ideal method of electric traction.

There is one question, however, that is of great and growing seriousness in electric traction, and that is the interference of an electric tramway of the ordinary type with the telephone lines in the vicinity. First, there is the danger of a cross circuit between their respective wires where the damage will be all on one side; and second, the fact that an electric tramway using ground connections may quite paralyse all the telephone circuits in the immediate vicinity. The first danger may be in great measure avoided by a proper system of guard wires, but the second difficulty is of no small moment, and cannot so easily be met. The effect of a traction line on all neighbouring telephone lines is very marked, in some cases rendering them almost useless. The exact nature of the phenomena produced is very complicated. Listening at a telephone thus affected, it is possible to follow in considerable detail the operation of the motors. Whenever a car is started, a low hum is heard, gradually rising in intensity and pitch as the speed increases, and as the connections are shifted from step to step on the switch-box. Beneath this distinct note is a confused whirring sound of lower pitch and greater intensity. The effects are clearly due to the super-position of several different periodic variations in the current and electromotive force on the traction line. The transference of this disturbance to the telephone line depends on two quite distinct causes; first, the direct effect of induction, and second, the disturbance due to the fact that both systems are grounded at points not very far distant from each other. The relative importance of these two causes varies very widely in different places. Here most of the trouble comes from direct induction, while it is not uncommon to find nearly all of it coming from the grounds. Both causes must in general be eliminated to avoid the difficulty.

Examine first the cause of the fluctuations which produce induction. Any motor the armature of which is wound in a finite number of sections must, in the first place, produce sinusoidal variations in the motor electromotive force. These, however, are of small amplitude, less than one-half per cent. in motors generally used, and are in this case of minor importance. Their period corresponds to N n per second, where N is the number of revolutions per second and n the number of segments in the commutator.

Besides this there is a periodic variation of the ohmic resistance of a motor due to the fact that the brush in sliding from segment to segment momentarily short circuits the ends of an armature coil. Let n be the number of armature sections and r the resistance of each, R_1 the resistance of the armature from brush to brush, and R_2 the resistance of the series field coils. Let the motor be supplied, as is usual, in practice at a constant electromotive force. Then, assuming the brushes to be 180 degrees apart and touching one segment the resistance of the motor is—

$$R = \frac{n r}{4} + R_2.$$

Now, revolve the armature until each brush touches two segments, and—

$$R = \frac{(n-2)r}{4} + R_2.$$

Therefore when the motor is running at a constant speed the current will be subject to fluctuations of amplitude determined by the above, and occurring n N times per second. Take, for example, the ordinary Sprague motor where $n=24$, $R_1=1{\cdot}2$, $R_2=3{\cdot}3$ (last step) $r={\cdot}2$, the amplitude of the fluctuation is somewhat over 2 per cent. of the normal current. As the cars are fitted with two motors in parallel, if the two sets of brushes short circuit simultaneously we should have a double effect and a variation of 2 per cent. in the total current through the car. If they do not short circuit simultaneously, a variation of half the amount 2 n N times per second.

Another small periodic disturbance is due to the fact that the brushes are very generally unsymmetrically placed, with the result that the motor electromotive force in the halves of the armature will be slightly unequal The result is as if a weak alternating current were acting in the armature with 2 N n alternations per second.

Another and more serious difficulty occurs when the insulation between the commutator segments is somewhere near the width of the contact edge of the brush. In this case there would be produced a fluctuation which might almost amount to a make and break, and would have N periods per second if the brushes were symmetrical, and 2 N if they were not. The fluctuations due to this cause are frequently considerable. Add to this the possible irregularities in the commutator contact, and we have a combination of sinuous and alternating disturbances of an immensely complicated kind.

Of course, the remedy for induction is well known—giving the offending current a return wire, so placed as to neutralise its effect, or adopting a simlar process, with the line disturbed. The case of earth disturbances has recently been investigated by Mr. Preece (*The Electrician*, Vol. XXII., p. 618.) His results show that the effect of a grounded sinusoidal current may extend to a great distance and may cause very much worse disturbance on a telephone line than simple induction. These facts would suggest that in all electric traction work a complete metallic circuit should be used, and that grounding *viâ* the rails should be avoided. Double contact wires, however, are certainly objectionable where they have to be supported by a system of wires, both as being somewhat troublesome mechanically and as being unsightly. Unless guarded with great care they will much increase the danger of troublesome short circuits. Where, however, they can be supported on brackets, and hence more efficiently guarded, their use should furnish an effective way out of the telephone difficulty. But in very many cases it is desirable to use the single overhead wire, and some simple means of avoiding at once earth and induction is desirable. Clearly it is not sufficient to use the track alone for a return or the track with an auxiliary wire beside it, as is quite usual. For the current of supply is, or always should be, divided between the trolley wire and a line wire connected with it at intervals; hence the inductive effect of this overhead system can never be balanced by an equal current along the ground by reason of unequal distance from the overhead telephone wires. I would therefore suggest the following as perhaps the simplest and easiest way of abolishing the induction:—Connect the rails so as to form a return circuit leading either back to dynamo or to a main earth at some unobjectionable point. Then remove the auxiliary wire from the track to form a second return circuit parallel to the line and nearer than it to the telephone lines. Finally connect these two return systems at any convenient number of points by wires under the surface and up the nearest pole. Neither track nor these cross wires need be carefully insulated. The supply current then is divided between line and trolley wire and the return between auxiliary line and track. The most of the former current would pass along the line wire and most of the latter along the track. Since the coefficients of self-induction will be quite nearly equal, the disturbing fluctuations will divide in the same ratio as the currents, and we have a system of four conductors in which the two fixed ones, trolley wire and track, nearly neutralise each other, the larger current being the more distant from any overhead wires; while the two movable factors, the two-line wires, can be so arranged as to complete the compensation. Given the resistances, such a system can be easily arranged, so that the resultant induction on any single wire would be *nil*, and remain very small throughout any compact system of wires. It would be practically very difficult to secure compensation with fewer conductors than four so long as two of them must be approximately fixed. This four-conductor system could be applied to existing lines with small trouble and expense.

I will now pass to the efficiency tests made on the electric road in this city. The Lafayette Street Railway Company operates 3·6 miles of single track on the Sprague system. The line was operated by horses until the summer of 1888, and has now been operated as an electric road about eight months. The track is a branching one, extending on both sides of the Wabash River and reaching well out to the city limits. The grades are in some places severe. In the central part of the city which lies in the old river bottom the grade is very light, but on the east side the road rises sharply, taking at first a slight grade and then one of about 6·6 per cent. and fully 800 feet long, averaging 7·34 per cent. for 100 feet in one section. On the west bank of the Wabash the road rises over the bluff, taking a 6 per cent. grade for about another 800 feet, with a very sharp

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curve near the middle point. There are more than a dozen curves in the road, most of them of a rather short radius. There are seven motor cars, of which six are in continuous use. The cars are closed, weigh complete about 5,200 pounds, seating 20 persons readily, and holding at a pinch between forty and fifty. The plant combines a plant for stationary motors with that for the street cars. There are two of the regular Edison railroad dynamos coupled in parallel, each having a normal capacity of about 30,000 watts at 500 volts, or rather more in case of need. Two other Edison dynamos of about half the capacity supply the power circuit at a potential of about 250 volts. Power is supplied by a Hamilton-Corliss engine, 14in. by 36in., running at 88 revolutions per minute. Two large horizontal tubular boilers furnish steam at a normal pressure of 85 pounds, and have a large margin of capacity. The two railroad dynamos and one of the power dynamos are used continuously, the former 16 hours, the latter 10 or 12 hours per day. The first car leaves the end of the road at 6:20 a.m., and the last car gets in at 10:20 p.m. Each car makes from 35 to 40 miles per day, is operated by a single man, and can, if necessary, take one of the spare cars in tow to accommodate an unusual crowd.

The first tests were made at the power station, with the object of determining the actual electrical output on the road, the indicated horse-power necessary to produce it, and the amount of coal required. To this end the engine was indicated every five minutes throughout the day, beginning and ending this series with a group of friction cards. Meanwhile the electrical output was simultaneously obtained from volt and ampere readings. The volts were read on an Ayrton and Perry voltmeter, and the amperes on the station ammeter, which was afterward checked as well as practicable by a new Ayrton and Perry ammeter. The coal burned during the test was measured and its weight determined.

The results of the friction cards were as follows:—Friction of engine + 3 dynamos average: morning, 12·5 indicated horse-power; night, 19·1 indicated horse-power. A number of cards taken on different days gave almost exactly 16 indicated horse-power, which we may take as a fair average for the power wasted in friction. The dynamos are all belted to a main shaft which is driven by a belt from the engine. This shaft is well in line and kept in good order. In fact,

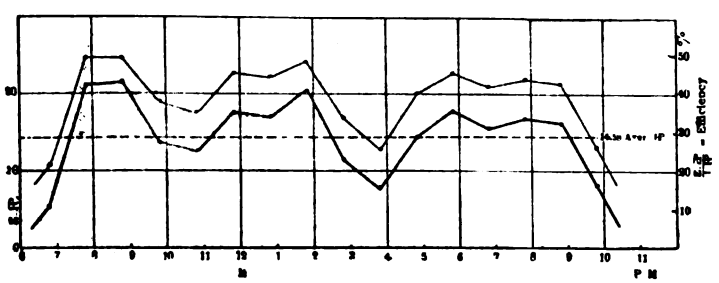

FIG. 1.—Variation of Electrical Horse-power and Efficiency, Lafayette, Ind., Electric Railway.

the station is a model of neatness and the machinery is looked after with unusual care. These figures give for the approximate friction of the engine alone 12—14 indicated horse-power. In other words, we may take the engine friction as 10 per cent. of its rated full power.

The five-minute indicator cards were worked up very carefully, and gave as the average continuous power throughout the day 39·05 indicated horse-power. The highest figure reached was 79·3 indicated horse-power, and from this figure the power fell to the friction cards as a minimum.

In a similar way the readings of volts and amperes were combined and showed an average that was remarkably low, being 10,881 watts, equal 14·58 estimated horse-power. The greatest output recorded was 90 amperes, 410 volts, 36,900 watts, equal 49·46 estimated horse-power. This figure was reached only for a few seconds. This is not as great an output as is sometimes observed on the line, where occasionally 75 estimated horse-power may be demanded, though such a call for power is quite unnecessary under ordinary working conditions. The ammeter readings not infrequently fell to zero for a few seconds at a time. To obtain the total electrical horse-power for comparison with the indicated horse-power, we must add to the above the amount obtained by a similar approximate integration of the power used on the stationary motor line, which was 1·25 estimated horse-power. The amperes on the car line varied from 0 to 90, and the volts from 405 to 480, averaging about 450. A sudden call for a large current invariably lowered the potential to about 410, and tended to slow the engine momentarily, for the governor only began to act some two seconds after the current rose; and so sudden are the variations in current that nothing short of compound winding can possibly keep the dynamo at anything like constant potential. The electrical output varied greatly during the different hours of the day. Fig. 1 gives this variation of the output with the time in a very marked way. The heavy line gives the estimated horse-power required hour by hour. The variation is very large, and causes a similar variation in the efficiency of the power-station, since the main losses are nearly independent of the output. Combining now the indicated horse-power at the engine with the estimated horse-power on the car line, and making proper allowance for the power consumed in the lamps and on the stationary motor line, we have as the average efficiency of the power station, $\frac{\text{E.H.P.}}{\text{I.H.P.}} =$ 40·7 per cent. average throughout the day, and for the maximum efficiency, $\frac{\text{E.H.P.}}{\text{I.H.P.}} = 65·0$ per cent. The light line in Fig. 1 gives the variation of the efficiency throughout the day.

The coal burned during the day was 4,500lb. of slack, which is at the rate of 7·31b. per indicated horse-power hour, or nearly 16lb. per estimated horse-power hour. We have shown in these facts by far the greatest source of loss in electric traction, both here and elsewhere. It is worth while considering in some detail the nature and cause of this loss, in how far loss at this point is necessary, and what means can best be taken to lessen it. The key to the whole situation lies in the immensely irregular calls for power in a tramway system. The cause of this irregularity is obvious; the annexed diagram (Fig. 2) will give a feeble idea of its amount. It shows the variation of the current on the line as given by the five-

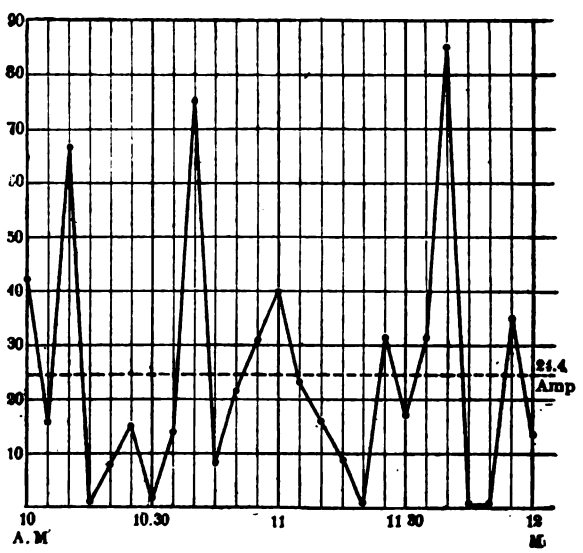

FIG. 2.—Variation of Current, Lafayette, Ind., Electric Railway.

minute readings between the hours of ten and noon on one of the days of test. Comment is unnecessary. But even this does not represent the real amount, for as a matter of fact the current is never even approximately constant for more than a few seconds at a time, and varies from *nil* to 60 or 70 amperes in a way that nothing but a continuous record can show. As a result of this, the mean output is, on a system of this size, less than 25 per cent. of the maximum, which may be called for and must be furnished at any moment. As the system becomes larger the ratio of mean to maximum output increases, until for a large system it may amount to one-half. The value of this ratio on the Richmond (Va.) road, judging from Mr. Sprague's figures, rises to nearly this amount. The values will then range from ·2 for a small road with high grades to ·5 or ·6 to a large road (40 or 50 cars) in a level region. Grades evidently tend to diminish its value considerably, though their effect may be partially counteracted in a small road by tact in arranging the schedule. To supply power to such a system an engine must be able to give the maximum power demanded on very short notice, and will be habitually worked at from a fifth to a half of its full horse-power. This affects the efficiency of the system in two very pernicious ways, first by requiring the use of a disproportionately large engine with friction to match, and second, by working that engine in a very uneconomical way. As regards the first count, the friction of an engine is nearly independent of the load, quite as often decreasing under heavy load as increasing. It gradually increases with the speed, and slightly increases with increasing length of cut-off. As to the amount of friction, it varies, of course, very widely, but in modern engines of good make it will generally be from 5 to 10 per cent. of the full normal output. This means, then, that if such an engine be worked on the average at a quarter of its full power the loss from

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friction will be from 20 to 40 per cent. of the indicated horse-power, usually much nearer the latter figure than the former. This is bad enough, but it is not the worst. When used under these circumstances, an engine is on the average working under conditions of expansion very far from economical. The cut-off is very much too short for advantageous working. The best point of cut-off is probably given by Emery's formula—

$$\frac{1}{r} = \frac{1}{1+\frac{p}{22}},$$

where r is the ratio of expansion and p the absolute pressure in pounds per square inch. Even this point of cut-off is probably rather small for ordinary engines. Applying the above formula to the case of the engine tested in these experiments, the best point would appear to be between one-fourth and one-fifth stroke. On examining the indicator cards taken at or near the point of average output, the engine seems to be cutting off at between an eighth and a ninth of the stroke. There is, therefore, a disastrous amount of condensation, and the final result appears in the 7·3 pounds of coal per indicated horse-power hour. A Corliss engine like the one in question should, if used under favourable conditions, give the indicated horse-power hour for three pounds of coal or less, while under this erratically varying cut-off it requires more than twice that amount. It is very important then to avoid as far as possible these very wasteful conditions of working. The problem then is to work an engine on the average at its most economical point of cut-off, while retaining the power of responding to sudden, though brief, demands for several times the average horse-power. In the first place, these sudden demands are sometimes but for a second or two, generally for less than half a minute, and whatever the engine used, a heavy fly-wheel would be of great service in smoothing the irregularities of the output and helping the engine through a sudden emergency. Second, the engine itself should have a very wide range of cut-off to enable one to make the average expansion the most economical one. In an engine which must be habitually used at one-fourth power, the steam should be made to follow for nearly full stroke if necessary, in order to bring the average point of cut-off to the right value. Any valve gear which cannot cut off beyond half stroke is decidedly objectionable, since it necessitates too large an engine and too great a ratio of expansion. To avoid friction as well, the engine should be the smallest, competent to furnish the maximum power; hence it should take high-pressure steam and have a high rotational velocity. As regards application of power, it should be as direct as possible, avoiding countershafts and the like. All these considerations point distinctly to the use of high-pressure steam in a rather small high-speed engine capable of cutting off up to three-quarters stroke, driving a heavy fly-wheel, and belted direct to the dynamos. Such engines can be obtained and are capable of giving the indicated horse-power hour on 3—4lbs. of coal. The day of low speeds and gigantic cylinders is fast passing by, and nowhere do they appear at less advantage than in work under extreme variations of load. An engine of the kind mentioned above would, under favourable conditions, have a coefficient of friction not exceeding 15 per cent. of the average indicated horse-power, and require less than 5lb. of coal per indicated horse-power hour, even under the variable load necessary. It should then be able, when belted direct to the dynamo, to give the electrical horse-power hour for about 7lb. of coal. The load being less variable in a large power station, conditions of economy are more easily reached, and as nearly as can be calculated from Mr. Sprague's data in the power station of the Richmond, Va., road, the estimated horse-power hour required about 9lb. of coal. As to the amount of power actually needed to operate a tramway line, the tests made here show almost exactly 2·5 estimated horse-power per car. This is a smaller value than would be obtained from a larger and more heavily-loaded line. The diagrams given by Mr. Sprague show that on the Richmond line the power required was approximately four to five estimated horse-power per car. The Richmond cars, however, are larger and heavier than those here. In general, the power required seems to be 3—5 estimated horse-power per car. To furnish this output the engine should be capable of producing about 10 to 15 indicated horse-power per car at full (say $\frac{2}{3}$) cut-off, the former figure for large and level systems, the latter for small systems and those with excessive grades. It should then be practicable to bring the efficiency of the power station, $\frac{\text{I.H.P.}}{\text{E.H.P.}}$, up to 70 per cent., in lieu of the 40 per cent. observed in these experiments. The efficiency of the Richmond system, which is operated by Armington and Sims' engines running at 250 revolutions per minute, must be somewhere near this figure, certainly as high as 60 per cent. This efficiency, it should be remembered, is not secured at any great expense, for such a plant is quite economical in first cost as well as in operation.

(To be continued.)

THE PHYSICAL SOCIETY.

The last meeting of the Society for the present session was held on the 22nd inst., Mr. A. W. Clayden read a note on

"Some Photographs of Lightning and of Black Electric Sparks."

The author exposed several plates during the thunderstorm on June 6, and three of these gave results.

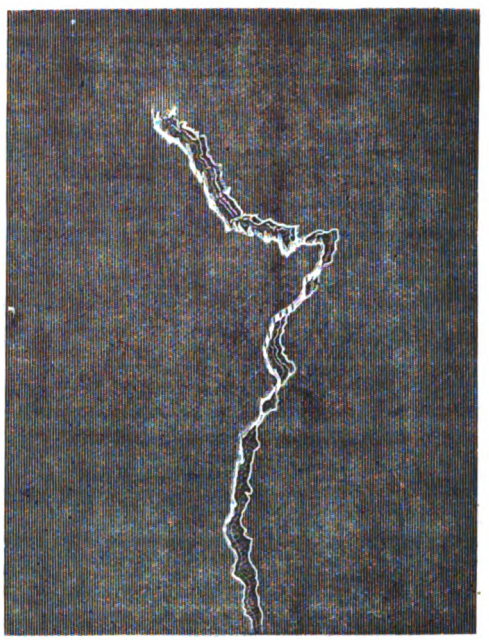

FIG. 1.

Two of the flashes of which photographs were obtained, exhibited complicated and beautiful structure.

They are shown in Figs. 1 and 2, which are taken from an enlargement of the original photograph.

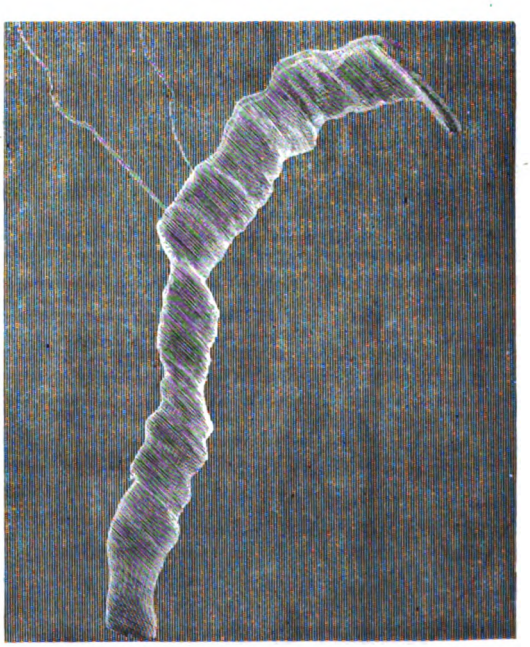

FIG. 2.

One of these is a multiple flash, the enlargement of which shows a curious flame-like appendage pointing upwards from every angle, while the other is a broad ribbon. Some masonry came into the field of view of the photograph, and this came out quite sharply in the negative, showing that no perceptible motion of the camera occurred during the existence of either flash. Another of the plates gave some very interesting results. During the exposure of the plate the author had noticed about six flashes which appeared likely

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to come within the field of view, especially one, which passed right across the centre of the field. On developing the plate, however, nothing was seen at first but one triple flash in the corner.

The plate was very much over-exposed, and the image required careful nursing. When the plate was carefully examined, however, the image of the vertical flash specially noted was discovered, together with several others, but they were all dark flashes. The enlarged plate showed indications of a white core to each of them.

The connection between this reversal and over exposure suggested to the author that the black images of the flashes might be due, not to the excessive brightness of the flashes, but rather to the cumulative effect of the glare from the illuminated white clouds forming the background. To put this idea to the test the author endeavoured to obtain similar effects with the sparks from a small Wimshurst machine giving sparks about an inch in length. He

FIG 3.—Bright sparks, different parts of the plate being exposed to diffused light for from 1 to 6 seconds respectively.

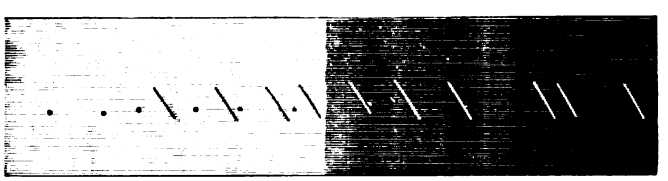


FIG 4.—Left-hand portion exposed to diffused light for 1 second.

FIG. 5.—Series of sparks with background of white cardboard.

first photographed a series of brilliant sparks obtained by including two large Leyden jars in the circuit. The results of these photographs were of a normal character, except that they shaded off at the margin in spite of the focus being good, as shown by the distinct image of the knobs of the machine. Photographs were then taken of the less brilliant sparks obtained when only the ordinary small jars were included in the circuit. The images were similar, but less dense. Both experiments were then repeated, but before developing, the plate was exposed to diffused light from a gas-flame. The fainter sparks were then completely reversed, while the bright ones were reversed at the edges, but had bright cores. Fig. 3 shows the result of exposing different parts of the plate for one, two, three, four, and six seconds respectively.

Fig. 4 shows the result of exposing half of a plate containing images of faint sparks to diffused light for one second before developing.

Fig. 5 shows the result of photographing a number of sparks in a series across the plate, with a background of white cardboard representing the white background of cloud in the photographs of lightning flashes.

Two of these sparks, viz., those marked 1, 1, in the figure show reversed images. They were among the first impressed upon the plate.

DISCUSSION

In the course of the discussion which followed, Mr. W. N. SHAW exhibited a photograph (Fig. 6) taken by his friend, the Rev. A. Rose, during the

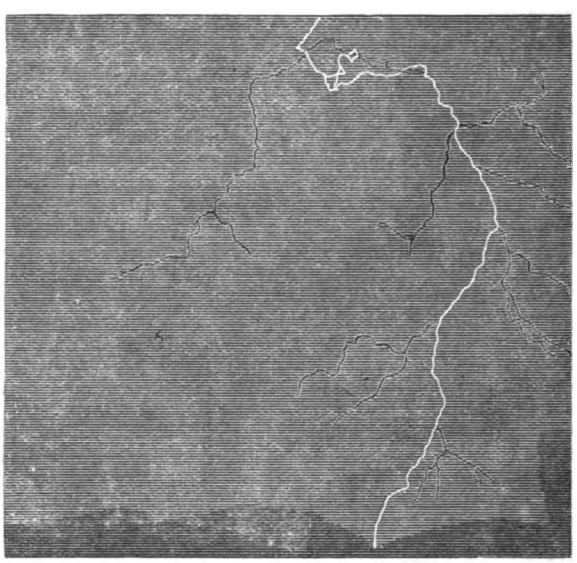


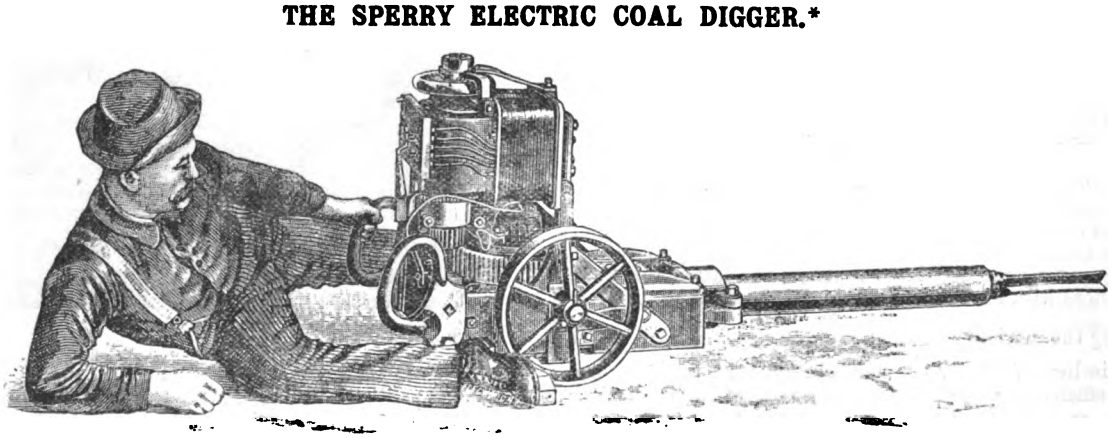
FIG. 6.

recent storm, which showed bright main flashes with dark flashes branching from it. He thought that the dark flashes could not be due to over exposure, as in this case the central part would be the most exposed. One of the side flashes showed a white line along its centre, which appeared to confirm Mr. Clayden's opinion that the reversing effect proceeded from without inwards.

Prof. PERRY thought that this photograph confirmed Mr. Clayden's theory, as the side flashes were not so bright as the central one.

Mr. CLAYDEN, in replying to the discussion, observed that the diffused light appeared in some manner to undo the photographic effect of the spark or flash. He did not think that Prof. Stoke's theory that the reversal was due to the absorbtive effect of gases produced by a preceding discharge along the same path could explain the existence of the unreversed core.

THE SPERRY ELECTRIC COAL DIGGER.*



At the last meeting of the National Electric Light Association, held in Chicago, the new Sperry Electric Mining Machine was exhibited for the first time. This machine has since been sent to the Paris Exposition, where it will be exhibited in operation. The machine is the latest of Mr. Sperry's many inventions. He was encouraged in perfecting it by Mr. A. L. Sweet, one of Chicago's most prominent coal men, who has in past years spent considerable money with other inventors in this line, but without practical result.

* From the *Electrical World* of New York.

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Though this machine was the first made, and naturally liable to some faults in construction, the results reached in actual work in the mines gave promise of a good future performance, which has since been verified by the second machine, which is illustrated below, and which gave the following results :—

Number of tons undercut, one man and one helper, 10 hours, 6ft. vein	110 tons.
Depth undercut	4ft.
Length of face	120ft.
Horse-power required on surface	2·55
Cost of wires per running foot	$0·02
Distance from power to face	1,600 ft.
Number of blows per minute	200 to 250

The machine has been handled by a number of miners experienced with mining machines. They are loud in its praise and pronounce it the easiest machine to run they ever held, that it is almost entirely free from *recoil* and that each blow can be put in exactly where it is wanted. One great advantage and a unique feature is that no matter at what point in the stroke the pick is arrested by the work or face it is returned from that point instantly for the next blow and does not stand and push the miner back. Both the time and the power which would go into the remainder of the stroke are saved. This most important result is accomplished in the following manner :—

A crank operates by means of a pitman to draw back or compress an extremely powerful spring. The crank is not attached rigidly to the power shaft, but is so arranged as to be automatically engaged with the power shaft only when the strain upon the crank is in opposition to the direction of rotation. When this strain is reversed at the back dead centre, and when it is such as to be coincident with the direction of rotation, then the crank is freed perfectly from the shaft and allows the projectile to be forced unimpeded forward. The pitman has a slot in it so that if the projectile is arrested in its work before the end of the stroke, the crank, owing to its momentum, will fly past the other dead centre and go as far up on its withdrawing stroke as the length of the pitman will admit, at which point it is instantly engaged with the rotating power shaft, and compelled to make the remainder of its compression stroke without waiting or standing at that point an instant. When this compression stroke is completed at the back dead centre it is again automatically released and another powerful blow delivered. The blow of the pick is very great and is well adapted for undercutting in hard clay or coal. It stands the hardest usage which has been given it.

Another advantage of this machine is that the cost of installing one or more in a given mine is materially less than the cost of placing one or more air machines in the same mine. A small dynamo, costing $800, resting on the floor of the shop or engine-room, takes the place of the heavy air-compressor, costing $3,600, and requiring a heavy and expensive foundation. Any ordinary engine can be used to run the dynamo, or water makes a desirable and economical power. An engine to run ten machines with a capacity of 1,100 tons per 10 hours costs $400. The wires are run in the entries in a few hours' time, and replace the expensive air pipes. There are no joints to be repaired or to be kept tight. Lights for the mine may be run from the same wires, and it has been suggested that the town be lighted by the same plant at evening, giving an additional revenue.

The following are some data furnished by Mr. Elmer A. Sperry, inventor of the machine, which will be of interest :—

At dynamo on surface	2·55 horse-power.
Watts dynamo on surface	1,579 watts.
Watts motor at face	1,532 watts.
Length of circuit	3,200ft.
Furnished to drill	1·73 horse-power.
Drop in transmission	2·25 volts.
Amperes (constant current)	20 amperes.
Efficiency of motor	85 per cent.
E.M.F.	80 volts.

THE LONDON COUNTY COUNCIL AND THE METROPOLITAN ELECTRIC LIGHTING SCHEMES.

The following is the letter addressed by the Board of Trade to the County Council in reply to their letter of the 6th ult. The Chairman of the Highways Committee, Mr. Benn, and one of the members of the Committee, have been requested to confer with the Board of Trade, with a view to amendments being made in the Order.

Board of Trade (Railway Department),
London, S.W., 13th June, 1889.

Electric Lighting Acts, 1882 and 1888.

Sir : I am directed by the Board of Trade to acknowledge the receipt of your letter of the 5th inst., and to request that you will convey to the County Council the thanks of the Board of Trade for the valuable assistance they have given in the matter.

The Board of Trade have considered the several suggestions made in your letter, and I am now to enclose a copy of a Model Order which they propose to follow in all cases of applications in the metropolis now before them.

With reference to this Order and the representations contained in your letter, I am to make the following observations :—

1. The Order to the London Electric Supply Corporation will be granted only on the condition that they provide duplicate sets of generating machinery and a duplicate set of mains in order to secure a proper and continuous supply in case of a breakdown of machinery or other defaults. And regulations will be subsequently issued to guard against danger to the public from currents of high tension.

2. Streets will be scheduled in the several Orders for the compulsory laying of mains, and provision is made for supply on proper requisition and on equitable conditions within the rest of the area of supply. There will be one exception to this rule. In the parish of St. James, the vestry have advised the Board of Trade that no streets should be scheduled, and, looking to the nature of the parish, the Board of Trade propose to defer to the opinion of the local authority in this respect.

3. Provision is made for the revocation of the Order, in case of default, in respect of the whole area, or, with the consent of the Undertakers, in respect of a part of the area, and that the consumer shall be called upon to bear only the cost of so much of any service line as exceeds 60ft. from any distributing main.

4. Provision is made for the removal within two years of all overhead wires erected by the companies, and for possible forfeiture of the Order if they invade or continue to invade a district within which they have no statutory power.

5. The proposed Clause 55 of the London Company's Order has been struck out.

6. The Board of Trade proposes that the Model Order shall be closely followed in all Orders, and, so far as possible, in all licenses granted in the metropolis.

7. Provision is made to extend the Metropolitan Subways Act, 1868, to electric lines where any subway has been constructed within the area of supply. But as regards future subways, and as regards the vesting in the County Council of the power to make subways in the London streets, the Board of Trade are of opinion that these are matters which cannot be dealt with by them in a Provisional Order. The same remark applies to giving a veto to the County Council on the opening of thoroughfares.

8. And as regards the exemption of the Council and vestries and district boards from liability in respect of damage done to mains in carrying out works of repair, and in the use of steam rollers, the Board of Trade think that if any change is made in the present legal position it should be dealt with by Parliament in a measure of general application.

9. In addition to the provisions for the protection of sewers contained in the Gas Works Clauses Act, which are incorporated with the Electric Lighting Act, provisions have been inserted in the Model Order for the protection of sewers from the operation of all works in their proximity.

10. Provision is made for the revision of price at the end of seven years on conditions to be then fixed by the Board of Trade. The Board of Trade, in the absence of accurate information as to the facilities for and the cost of supply of energy, think that it would not be reasonable to fix now the scale to be made applicable seven years hence.

11. Provision is made to prevent the acquisition without the consent of the Board of Trade by one company of the undertaking of another, and the association of one company with another supplying or intending to supply energy. But the Board of Trade do not think that they could properly propose to Parliament that Parliament should part with its own powers of dealing with any future proposal to extend the statutory area of supply of any company.

12. The price to be charged to local authorities is to be made the subject of agreement.

13. The minimum charge for supply is fixed at 13s. 4d. a quarter.

14. The Board of Trade concur in the view that, as far as is consistent with the principal Acts, there should be one controlling authority ; and, with this object, they have vested in the County Council the appointment of inspectors to—(*a*) Inspect lines and works. (*b*) Test currents. (*c*) Certify meters as being of a pattern approved by the Board of Trade. (*d*) Take proceedings.

15. The cost of providing adequate testing stations will devolve on the companies.

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16. But the Board of Trade do not consider that they could properly insert in a Provisional Order, or in a Bill confirming a Provisional Order, a clause or clauses limiting or determining the powers of purchase given by the general statute to local authorities. The Board of Trade admit the force of the arguments which may be used in favour of setting up one purchasing authority for London, but they are clearly of opinion that this can only be done by a general Act.

In drafting the Model Order, it will be observed that the Board of Trade have given effect, in all cases where it was possible for them to do so, to the wishes of the County Council, whose desire to facilitate the working of the companies' undertakings under proper safeguard of the public interests they fully recognise.

In apportioning the areas, the Board of Trade have departed very slightly from the recommendations contained in Major Marindin's report. It has been the earnest object of the Board of Trade to give effect to the views of the various local authorities. But it has been found impossible in the apportionment to carry out in detail all the wishes of the local authorities severally concerned. The Board of Trade have had to regard the Metropolis as a whole, and they are pleased to observe that the County Council support generally the recommendations as to area made by Major Marindin.

In conclusion, I am to state that it is most desirable that the Provisional Order should be confirmed by Parliament this year, and they propose to introduce the necessary Confirmation Bill at the earliest possible date after the reassembling of Parliament on the 17th inst.—I am, Sir, your obedient servant,

COURTENAY BOYLE.

The Clerk to the London County Council.

REPORT ON THE FIRST SIX MONTHS' WORKING OF THE ELECTRIC AND ALLIED TRADES' SECTION OF THE LONDON CHAMBER OF COMMERCE.

We have been furnished with a revised copy of the report prepared by the Secretary, which was read at the meeting of the Section on Monday, 24th ult., and ordered to be supplied to the Electrical and Engineering Press:—

"This Section was finally organised at a meeting of the trade held on the 22nd October, and a Working Committee was then elected. The Committee was divided into the following sub-sections:—Telegraph Companies, Telephone Companies, Electrical Manufacturers and Contractors, Electricity Supply Companies, Consulting Electrical Engineers, and General Engineers. The Electricity Supply Sub-Section was the first to get to work; on the 16th November it met, and considered the relations between the supply companies and the local authorities in regard to Licenses and Provisional Orders. It recommended the Executive Committee to memorialise the Board of Trade that the unit should be increased from 1,000 to 10,000 watt-hours, also there should be united action on the part of Undertakers in dealing with the question of paying the legal expenses of local authorities, as in some cases such payments had been demanded. It also asked the Committee to urge all the Electric Supply Companies to stand firm on the question of declining to sell undertakings at a shorter period than the 42 years' limit obtained under the recent Act, that Supply Companies should require two years as the minimum period in which compulsory work should be carried out, and that the model forms of accounts and general regulations for the Electric Supply Companies proposed by the Board of Trade should not be issued until the Supply Companies had been at work for at least a couple of years, in order that these rules and forms of accounts might be issued after reasonable experience had been obtained to suggest the best form for them. These recommendations were confirmed by the Committee at a subsequent meeting and communicated to those interested in the trade.

"Early in the year a Sub-Committee was appointed to consider the proposal of pushing the question of obtaining a Government laboratory for standardising electrical measuring instruments, and it was decided to take common action with the Institute of Electrical Engineers. Accordingly a Joint Committee was appointed, which met several times, and eventually, on the 19th June, an influential deputation representing the Chamber of Commerce and the Institute of Electrical Engineers attended at the Board of Trade, and laid before the President a scheme and estimate for such a laboratory. The deputation was favourably received, and there is every reason to believe that the matter will no longer be shelved.

"The question of overhead wires was taken up on the 4th February by a Committee appointed to examine the matter. This Committee held several meetings, and eventually has succeeded in obtaining a copy of the draft regulations intended to be issued by the Board of Trade for the regulation of overhead wires. The Committee hope to be able to obtain some modification of some of the more stringent regulations proposed by the Board of Trade, and which appear to press hardly on the trade. At any rate, they have good reason to believe that their representations will secure the issue of the rules in a modified form for country installations.

"A Committee was appointed to see whether some modification of the Chamber of Commerce rules respecting arbitrations could not be made so as to invite members of the Electric Trade Section to avail themselves largely of such arbitrations as a convenient method of settling disputes in the trade, and eventually the permission of the General Council was asked to the following modification:—That as disputes on electrical matters at present were somewhat complicated and involved much expert knowledge, disputants should, if they so agreed, be permitted to avail themselves of the services of counsel and expert witnesses in arbitrations otherwise under the Chamber's rules.

"A Committee was appointed to consider whether a standard form of specification could not be drawn up for the convenience of consulting electrical engineers on the lines of the specification very generally used by architects and builders. It was found, however, that for the present such a form of specification was not generally called for, and the idea was abandoned.

"The question of the railway rates under the new Railway Act was considered as far as it referred to electric trades. A Sub-Committee prepared a report on this subject, which was presented to the General Committee on the 13th of May, and it was subsequently revised according to the form adopted by the Chamber of Commerce generally, and finally lodged by the Board of Trade and railway companies on the 3rd of June.

"The Electrical Section enjoys great advantage in such cases in being able to avail themselves of the great experience and *prestige* of the Chamber of Commerce itself on a matter which so greatly affects the future commercial interests of every member of the trade.

"After the experience gained during the first three months the Committee of the Section decided that the amount of useful work done could be greatly increased if the Section secured the services of a gentleman thoroughly acquainted with the trade, to act as the Section's correspondent, and after due permission had been obtained from the Council of the Chamber it was decided to ask Mr. Trotter to accept the post. Mr. Trotter kindly consented to this, and the result has been shown in the greatly increased volume of the useful work which has passed through the hands of the Committee since the date of his appointment."

PARLIAMENTARY INTELLIGENCE.

The Government and the Telephone Companies.

In the House of Lords last night,

The DUKE OF MARLBOROUGH rose to call attention to the negotiations stated to be going on for an amalgamation of the principal telephone companies in the kingdom, and to move that the Post Office withhold any consent to the establishment of such a monopoly before a Joint Committee of both Houses of Parliament shall have considered the general conditions under which the telephone companies at present carry on their business, and the right by which either telephone or electric light companies have been establishing a gigantic public nuisance by the running of overhead wires in all directions across main thoroughfares, and have considered further whether it would not be advisable for the Government to establish a general system of telephonic communication throughout the country in connection with the work of the Post Office. This subject, the noble Duke said, had not been discussed in either House of Parliament, but it was one of great public importance. Notice had appeared that it was the intention of the principal companies to amalgamate and form one large system for the purpose of carrying on telephonic communication throughout the country. When the United Telephone Company was introduced, the Government, exercising their powers, claimed the rights of the telephone as being part of the purchase of the telegraph companies, and, being successful in litigation, an arrangement was come to by which the Telephone Company were allowed to carry on the business on payment of royalties. The time had now come when the patents were about to expire; and it appeared to himself and many others that the Government should lose not a moment in determining the attitude they meant to adopt towards the telephone companies. It might be supposed that in view of the unremunerative bargain made with the telegraph companies the Government would not be disposed to encourage the telephone companies; but that policy would be suicidal. Telephonic communication would never be successfully established in this large and important city, and throughout the country generally unless the Government were prepared to take up the question. They now had the means of doing it. They had a reversion of this valuable invention, which was already the subject of an established provisional experiment, by means of which the United Telephone Company

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had developed a system, not in itself complete, but more or less efficient. There were, however, many gaps in the system; there were delays in obtaining communication, the whole of which resulted from the great disadvantages under which telephone companies laboured—the difficulties of obtaining way-leave and those other disadvantages ever present to a private company in the establishment of a great net-work of communication, without having absolute rights upon which it could work. At present there was no controlling authority in respect of overhead wires; and no private individual could object unless he could show that his freehold was interfered with. As a consequence telephone and electric lighting wires were being run up in every direction, absolutely disfiguring the metropolis and increasing the danger of locomotion. In this respect, matters had come to a point; and he asked whether the subject should not be considered by a Joint Committee of both Houses. The telephone had been so improved that it could be utilised over a distance of one hundred miles; and in a small country like England there would be no difficulty in connecting many of the larger towns, thus giving an enormous advantage to commerce. Such a system could not be carried out by a private company. The Government alone was able to undertake the work and develop it and make it prosper, as had been demonstrated by the Parcels Post system. Another consideration for the proposed Committee was the question of way leave. In the face of the great experimental work carried on by the telephone companies, wires had been run in all directions, and in the course of time some prescriptive right might be claimed for this peaceful occupation. A similar position might be taken up by the electric lighting companies acting under Provisional Orders. In an old town like London it was impossible to lay all these wires under ground. The trenches required, even in modern cities in America, were very large. Enormous difficulties were encountered in running overhead wires owing to the hostility of owners of property. The Grosvenor Gallery Electric Lighting Company was the most successful in London, chiefly because it had been able to depend almost entirely on overhead wires, and he was bound to confess that in a place like the metropolis he did not believe it would ever be possible to supply the subsidiary force required in electric lighting without overhead wires. The Joint Committee would do well to consider the rules and regulations under which overhead wires should be erected. One suggestion was that lines of communication should follow lines of streets; that derricks should be of strength and weight sufficient to carry the cable swinging between; that the swing of the cable should not be excessive, and should not cross main thoroughfares except at stated points.

The MARQUIS OF SALISBURY said that the fact that the patents would expire in the course of a short time made it necessary for the Government to determine what course they would pursue. He did not think it desirable to examine the points at issue between the Government and the companies, because they were matters to be considered by the Committee, and he would probably prejudge the case. He could only say that the Government had no objection to the proposal in the first part of the noble Duke's motion. He (the Marquis of Salisbury) was not sure that the second subject ought to be adopted as part of the same inquiry. It seemed to belong to the jurisdiction of those who exercised power over public thoroughfares. In any case the noble Duke would find the inquiry sufficiently protracted on the first issue to occupy the Committee for the remainder of this Session to induce him to confine it to that point.

LORD BALFOUR OF BURLEIGH thought it extremely desirable in future discussions to separate more than the noble Duke had done the two subjects of telephone communication and electric lighting wires. Their lordships should be reminded that the Bill amending the Electric Lighting Act of 1882 conferred special powers on the Board of Trade for regulating overhead wires for electric lighting. These regulations were in an advanced state of preparation, and as soon as possible they would be communicated to Parliament. By the Provisional Orders obtained under the amended Act of last session, electric lighting companies in the metropolis were required to remove overhead wires within a specified time, and that arrangement was in process of being carried out without undue hardship on the companies. As to the Grosvenor Gallery Company, they had acquired a site at Deptford, where extensive operations were to be conducted, and it was anticipated that within a reasonable time it would be possible to arrange for the removal of a large number of overhead wires. As to the telephone companies, it was perfectly true the Board of Trade had no authority to deal with them.

The DUKE OF MARLBOROUGH said he was impressed by the advice of the Prime Minister as to the advisability of confining the reference to the Committee, to the adoption by the Post Office of the telephone system, although he thought there was plenty of time for inquiry, seeing that the patents did not expire for two years.

The MARQUIS OF SALISBURY: At the end of next year.

The DUKE OF MARLBOROUGH added that if the Committee commenced its sittings next Session there would be time to secure legislation. As to the works at Deptford, it might be possible to bring a current of 4,000 volts by underground wires, but it was in distributing the force into 2,000 volts over a wide area that the necessity for overhead wires arose. It was necessary Parliament should deal with this question of overhead wires. There was no city in civilised Europe so behindhand as London in telephonic communication, and certainly none so absolutely spoilt and disfigured by wires running in all directions.

The MARQUIS OF SALISBURY said it was certainly desirable that Parliament should be in a position to legislate before the conclusion of next Session.

The DUKE OF MARLBOROUGH said he would withdraw his motion with the view of proposing it at the beginning of next Session.

The motion was accordingly withdrawn.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June* 22, 1889.

A great deal of interest is being taken at the present time in this country in the subject of submarine cables. It is observed that there is great activity in bringing cable schemes before the public, and there is good reason to believe that we are about to enter upon another season of activity, both in Atlantic and Pacific waters; but nobody can see where the United States are likely to reap any profit or glory whatever out of the work. In view of the prodigious quantities of cable turned out here for aerial, underground and submarine work, it is a little strange that America has done practically nothing in the department of deep-sea cable laying. It is to her credit, of course, that she has given her liberal support to cable projects from time to time, and we are not likely to forget the pioneer work of Mr. Cyrus Field. But it does seem as though, in an electrical country like this, we ought to have succeeded in securing some contracts for deep-sea work. At the present time the project of a cable from the United States to Brazil has been revived by the Brazilian Government itself, apparently with every likelihood of carrying the scheme through. Then we have the Chilian Government advertising in our daily papers for contracts for a cable to be laid around the Straits of Magellan, while a new cable is talked of to be built by German capital from Ostend to Portland, Maine, and a Pacific cable is talked of and subscribed for to connect San Francisco with the Sandwich Islands. Then there are two or three Canadian projects, and the new cable from Halifax to Bermuda. Thus it will be seen that, as you may have already noted in England, the air is full of cable projects, and while some of these schemes may come to naught it is tolerably certain that others will be carried out. Perhaps with the record of so much honourable achievement in other electrical fields, America might well let England alone in her hitherto unquestioned supremacy in cable-laying enterprises, but I really should not be surprised if American capital were found entering the lists to secure a part of the work. With regard to the Brazilian cable, it will probably be remembered by some of your readers that a company named the Pedro Segundo was formed some time ago in this country, to carry out the work under what is known as the Cummings Concession. It is now understood that this Concession has lapsed, but it seems likely that Americans will after all try to control this cable, which is of so much importance to American political and commercial interests.

Some extent to which electric lighting is carried on board American vessels may be formed from the superb new steamer "Puritan," which begins this week to ply through the Sound between New York and Fall River. This passenger boat is undoubtedly by far the finest specimen of marine architecture of her class afloat. A great many English electricians have navigated the waters of the Sound on board the older steamer of the line, the beautiful "Pilgrim," and they will perhaps remember that on board that vessel not only was electricity the sole reliance for lighting the interior of the steamer, but that it was applied to all the side, head and steering lights. When this was done four or five years ago it was regarded as a pretty hazardous piece of work, and cautious people thought that the steamship company ought to have some sort of lighting provision other than electricity in reserve. The results have vindicated the courage and skill of those who made the Edison installation on board the "Pilgrim," and now we find the larger, and even more magnificent "Puritan" fitted out on the same lines electrically, her sole dependence for illumination being upon an Edison plant of 1850 lights driven by special Armington-Sims engines. In the "Puritan," moreover, some very novel effects in the way of illumination have been attempted and successfully carried out.

We have lately had some very interesting tests made here in regard to work and efficiency of electric roads. I believe I have before remarked on the fact that owing to the newness of this industrial department it has been difficult to get at satisfactory

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figures with regard to the cost of operation by electricity and the economical results obtained by the substitution of electric motors for horses, steam, locomotives, or the cable. One good test was made a short time ago on the Daft-road at Asbury Park, the figures of which I mentioned in this letter. A test which goes even further has recently been completed by Dr. Louis Bell, of Purdue University, Lafayette, Indiana, on the Sprague electric road in that city.* This road operates a little more than 3½ miles of single track on the Sprague system. It was run by horses until the middle of the summer of 1888, and has now been operated electrically for about eight months. It includes grades of 6 or 7 per cent., and one 7·34 per cent. grade on a stretch 800ft. long, while there are at least a dozen curves, most of them of short radius. There are seven motor cars on the road, of which six are in continuous service. The plant is driven by two Edison dynamos, each of a normal capacity of 30,000 watts at 500 volts, and it is worthy of note that there are two other Edison machines of about half the capacity in the same station supplying current to stationary motors for manufacturing purposes, &c., at about 250 volts. This plant is driven by a Hamilton-Corliss engine, 14 by 36in, running at 88 revolutions a minute, taking steam from two large horizontal boilers, at a normal pressure of 85lb. Each car makes from 35 to 40 miles per day, and is operated by one man. The tests applied under these conditions brought out some interesting figures. It appears that the amperes on the car line varied from 0 to 90 and the volts from 405 to 480, averaging about 450, a sudden call for a large current invariably lowering it to about 410 volts. The electrical output varied also greatly during the different hours of the day. It was found that the amount of power actually needed on the average to operate the line was exactly 2½ electrical horse-power per car; but the efficiency of conversion from the indicated horse-power at the engine to the electrical horse-power did not average more than 40·7 per cent., though it rose to a maximum of 65 per cent. at one time. At Richmond, on the Sprague-road, the diagrams made showed that the power required there approximated to 4 to 5 electrical horse-power per car, but the Richmond cars are much larger and heavier than those of Lafayette. The coal burnt during the day at Lafayette was 4,500lb. of slack, which was at the rate of 7·3lb. per indicated horse-power per hour, or nearly 16lb. per electrical horse-power per hour. As Dr. Bell shows that there was a further efficiency on the line of over 90 to 95 per cent., while the motors may be depended upon for an average of 80 per cent. on the level and 70 per cent. on sharp grades, the dynamo running at an efficiency also of at least 90 per cent., it will be seen that such a coal consumption is larger than is permissable or warranted. The fluctuations in the power required are necessarily enormous and very frequent, and hence with engines set for economical work at one fixed load, the conditions become wasteful. Dr. Bell further points out that the direction in which to work to increase the efficiency of the electric motor is decidedly more in the direction of adopting the steam-engine to this class of work than in attempting to increase the already remarkably high electrical efficiency. The problem he presents is that of working the engine on an average at its most economical point of cut off, while combining with that feature the power of expanding to sudden, though very brief demands for several times the average horse-power consumed. As to the results obtained with the road in general, Dr. Bell points out a number of excellent features, and says very pertinently that the live question to-day does not involve the chances of the electric road, but the fading hopes of its competitors. He points to the number of roads on which electricity has replaced horses, and says that while no inroads have yet been made on cable systems it is open to doubt whether they can hold their own even in the favourable localities where they are already established. Dr. Bell also points out that while all traction systems are liable to occasional mishaps there are many advantages in favour of electricity, one of which is the great power of varying the speed. Another point, which he does not include in his list, I notice, is that of backing the car. In this respect the cable car is helpless and hopeless, and the ease with which the electric car can be stopped and reversed never fails to make a most favourable impression on street railway men. Altogether, Dr. Bell's investigation is one of the most thorough and exhaustive yet made in this line of work.

An interesting form of meter has just been patented by Mr. Gustav Pfannkuche, who is now connected with the Brush Electric Company of Cleveland, and who has already done some important work in regard to distribution and measurements. In this new instrument of his Mr. Pfannkuche resorts to the principle of the well-known thermopile in an ingenious manner. The thermopile, or thermo-spiral, which he adopts is acted upon by the heat generated by the current in the main circuit, and the current which has thus been generated in the thermopile is measured in a suitable galvanometer in the ordinary manner. In the operation of this apparatus the current to be measured, or a portion of it, is first converted into a thermo-electric current, the thermopile practically answering in function to a converter, the primary coil of the thermopile being represented by a heat bar or device through which the current to be measured is passed. As variations of heat applied to the alternating joints of the thermopile produce variations in the current generated, so the variations of the currents to be measured by this new instrument are indicated by the variations in the strength of the thermo-electric current.

[* We reprint this article in another column, but our correspondent's excellent summary will be found to give all the most salient features.—Ed. *E.*]

CORRESPONDENCE.

SUPPRESSING SPARKING IN ELECTRO-MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your 14th June number (Prof. Thompson's Paper) an electrical device is mentioned at bottom of page 151 of "layers of foil between the windings," and stating further that "this method was patented by Paine and Frost in 1870, and rediscovered by Prof. Arons in 1887."

This arrangement was well known some years earlier than the dates given. It was one of two methods recommended by myself to the Electric and International Telegraph Company for the purpose of delaying the demagnetisation of a certain part of the translating apparatus employed on long lines. I believe one form is still in use for the same purpose in the Postal Telegraph apparatus, and is mentioned by Mr. Preece in his Paper on Shunts, read before the Society of Telegraph Engineers.

The effect of both methods was to reduce the spark, and at the time delay the demagnetisation.—Yours, &c.,

17 and 18, Cornhill, E.C., F. Higgins.
1st July, 1889.

COMPANIES' MEETINGS & REPORTS.

The United Telephone Company (Limited).

An extraordinary general meeting of this Company was held yesterday at the City Terminus Hotel, Cannon-street, Mr. James Braud presiding.

The SECRETARY (Mr. Thomas Blaikie) having read the notice convening the meeting,

The CHAIRMAN said that the meeting was purely a formal one called for the purpose of confirming resolutions passed at the last meeting. Since that meeting the only matter of importance that had occurred was the writing of a letter to the secretary by the Postmaster-General, which letter was published in the newspapers, which he had no doubt they had all seen, as well as the reply to it on the part of the Directors, who naturally felt that they had had the best of the correspondence. Since then the Postmaster-General had written another letter, which was also published, but to which they did not deem it necessary to reply, thinking it better to leave the public to form a judgment as between the telephone companies and the chief of the Post Office. The Directors were doing what they believed they had a perfect right to do. They were not seeking to interfere with the Postmaster General or the Government in any way whatever. Their object in amalgamating was to make themselves stronger financially, and in other ways. Furthermore, they wished to give a better and cheaper telephonic service to the public. He then moved *seriatim*, and Mr. J. S. FORBES seconded, the confirmation of the following resolutions,

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which were passed at the ordinary meeting of the Company on the 4th prox.:—

"*That the agreement submitted to this meeting, and expressed to be made between this Company and the National Telephone Company (Limited) for the amalgamation of the two Companies, by a transfer of the business and property of this Company (with certain exceptions) to the National Telephone Company (Limited), in consideration of shares in that Company be and the same is hereby confirmed.*

"*That with a view of giving effect to the above-mentioned agreement, and in order to enable the shares to be allotted thereunder to be distributed among the members of this Company, this Company be wound up voluntarily, under the Companies' Acts, and that Mr. Thomas Abercrombie Welton be, and he is hereby, appointed liquidator for the purpose of winding up its affairs and distributing its property.*

"*That pursuant to the 161st Section of the Companies' Act, 1862, the Liquidator be, and he is hereby authorised, to carry the said agreement into effect, and to receive the shares agreed to be allotted thereunder and to distribute the same, together with the shares of the National Telephone Company (Limited), already held by this Company, in specie, among the members of this Company.*"

The resolutions having been unanimously agreed to,

The CHAIRMAN said it was his painful duty to bid the shareholders good-bye as Chairman of the Company. He had occupied the position ever since the Company was started. Before that period he was Chairman of the Bell Telephone Company, who first introduced the telephone into this country. He, and a few friends, some of whom he saw around him, bought the wonderful instrument from Prof. Bell. They found it, however, impracticable for the commercial working of the exchange system, and so they joined with Mr. Edison and his friends and bought up the property of the Blake transmitter, working ever since under the title of the United Telephone Company. He had had, therefore, the pleasure of presiding over the Company in its boyhood, in its youth, and its lusty manhood, and now he was helping them to do that which was good for all strong men, namely, to get married. He had had the pleasure of seeing their shares go from £5 to £15 and their dividend from almost nothing to 17½ per cent., so that he thought he was entitled to regard his record with satisfaction. He hoped that the shareholders would think that on the whole he had served them well. On the new company they would have a very excellent board, they would be all men well qualified to conduct their affairs with success. He did not know who was to be Chairman, but his task would be somewhat easier than what the board of the United Telephone Company had to face when they began their enterprise.

Mr. F. FAITHFULL BEGG expressed his regret at the decision of the Chairman, which he said took all the shareholders by surprise.

Mr. J. W. BATTEN also said it was a matter of surprise to him that Mr. Brand should come to such a determination. From the very day that Mr. Brand joined the Company to the present time the telephonic industry had never been absent from his thoughts. He had devoted all his time and energy to it, and he (the speaker) hoped that the meeting would ask Mr. Brand to still continue to be on the Board of the new Company.

Mr. D. PARRISH and Mr. W. CUTHBERT QUILTER, M.P., having also expressed their regret at the Chairman's decision,

The CHAIRMAN said that he was very grateful for the handsome way in which his past services to theCompany had been referred to. He did not intend on that occasion to enter into any of the reasons which had made him come to the conclusion he had done. If the meeting of the United Telephone Company had requested him to reconsider his intention, of course it would have been his bounden duty to do so, and he would have had the greatest pleasure in endeavouring to meet the wishes of those whom he had tried to serve so well; but the matter did not depend on the shareholders of the United Telephone Company. A request of that kind would have to come from the representatives of the new company.

Col. R. RAYNSFORD JACKSON proposed a vote of thanks to the Chairman not only for presiding over the meeting, but for the services he had rendered to the shareholders and the country in promoting telephonic enterprise.

Mr. J. S. FORBES said he was very reluctant to take part in the discussion. The announcement of Mr. Brand's retirement from the Board of the newly-constituted Company came upon the speaker as a surprise. Mr. Brand's connection with the Company had been so long and so well known, that it required no eulogy from him. The shareholders had had ample opportunities from the results of his administration of forming an opinion of their own on that subject. The speaker wished, as a matter of feeling, that Mr. Brand had been able to put them a little more fully in possession of the reasons, which had satisfied his mind that, on the eve of so important an event as the absorption of three companies by one, he should withdraw his services from the concern. The speaker thought it would be undesirable that a discussion, as to the constitution of the new board, should take place at a public meeting; but he would go so far as to echo the feeling expressed by Col. Jackson, and to appeal to Mr. Brand to reconsider his decision—at all events, until he heard what the feelings of his various colleagues in the new company might be, and what precise position they would assign to him in the new company. Mr. Brand's resignation would, he was sure, prove very embarrassing to his colleagues.

The CHAIRMAN said that he was very much gratified by the kind words that had fallen from Mr. Forbes, and after a brief consultation with those who had been so long connected with him on the Board of the United Telephone Company, he had come to the conclusion to let matters stand as they were for the present. It would be the last thing in his mind to put his colleagues to any inconvenience.

Mr. FORBES then formally seconded Colonel Jackson's motion, which was cordially passed, and

The CHAIRMAN having briefly replied, the proceedings terminated

The National Telephone Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held yesterday at the City Terminus Hotel, Cannon-street, Colonel R. Raynsford Jackson presiding.

The SECRETARY (Mr. William B. Campbell) having read the notice calling the meeting,

The CHAIRMAN proposed—

"*That the following Agreements be and the same are hereby adopted and confirmed, viz.:—*

"(a) *An Agreement made between the United Telephone Company (Limited), of the one part, and this Company of the other part, for the transfer of the United Company's business and certain property to this Company for shares in this Company.*

"(b) *An Agreement made between the Lancashire and Cheshire Telephonic Exchange Company (Limited) of the one part, and this Company of the other part, for the transfer to this Company of the business and certain property of the Lancashire and Cheshire Company, for shares in this Company.*"

Mr. GARNETT seconded the resolution.

The CHAIRMAN, in reply to Mr. Buchanan, said that the recent correspondence in *The Times* on the part of the Post Office officials had caused the Directors no anxiety whatever, and had not influenced them in departing from the course which they had already mapped out for themselves. Neither did they think that there was any reason why the shareholders should trouble themselves in the matter. He anticipated that the Postmaster-General would content himself with the protest he had made, and probably, if, hereafter, he resolved to buy the telephone companies, he would refer the matter to the arbitrator. They were aware that if the Postmaster-General should resolve at the first break in the period of the license to buy the telephone systems, the price to be paid for them would have to be fixed by an arbitrator, and the speaker had no doubt that the Postmaster-General was preparing for himself a series of arguments to influence the decision of the arbitrator. He looked upon the action of the Postmaster-General as having no object beyond that.

Mr. F. R. LEYLAND said he would like to say that this matter had been carefully studied by all the Directors before entering into it. The first thing that naturally presented itself to them was this question, "Will the adoption of the proposed scheme in any way imperil our license?" They took the very best advice they could get on the point. They consulted two of the leaders of the Chancery bar, Sir Horace Davey and Mr. Rigby, Q.C., and their advice was that there was nothing whatever in the license that would be infringed or affected in the slightest degree by the proposed scheme being carried out.

The motion was then agreed to.

The CHAIRMAN moved and Mr. BRUCE seconded the next resolution, as follows:—

"*That the capital of the Company be increased by the sum of* £3,250,000, *by the issue of* 650,000 *new shares of* £5 *each.*"

The motion was agreed to *nem. con.*

The CHAIRMAN moved and Mr. GARNETT seconded the next resolution, as follows:—

"*That the regulations of the Company be varied by substituting for the existing Articles of Association, the Articles, a print of which is now submitted to this meeting, signed for verification by the Chairman of the meeting and the Secretary, and that such last-mentioned Articles be the regulations of the Company in the place of the existing regulations.*"

The CHAIRMAN proposed and Mr. LEYLAND seconded the following resolution:—

"*That in order to give effect to the new regulations of the Company, all the directors holding office prior to their adoption be removed from office.*"

Mr. W. A. SMITH proposed—

"*That Charles Swain Agnew, Esq., John Winterbotham Batten, Esq., James Brand, Esq., John Bruce, Esq., James Staats Forbes, Esq., Peter Garnett, Esq., Eli Heyworth, Esq, Colonel Robert Raynsford Jackson, Frederick Richards Leyland, Esq., Joseph Bond Morgan, Esq., Dillwyn Parrish, Esq., William Cuthbert Quilter, Esq., M.P., George Hunter Robertson, Esq., Samuel Herrick Sands, Esq., and Alderman Joseph Thompson, be and they are hereby appointed directors of the Company.*"

He had never seen, he said, a stronger board to guide the destinies of a company, and on that account they had great prospects of success.

The resolution, which was seconded by a shareholder, was carried unanimously, and the proceedings terminated.

The West African Telegraph Company (Limited).

The fourth ordinary general meeting of the Company was held at Winchester House, Old Broad-street, on Tuesday last, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. Wm. Payton) read the notice convening the meeting and the minutes of the third ordinary general meeting.

The following is the report of the Directors for the year ending December 31, 1888, which was taken as read:—

The gross receipts, including the balance brought down from last account (£1,215. 9s. 11d.), amount to £56,530. 12s. 11d., the general expenditure being £20,016. 0s. 7d. There remains a balance of £36,514. 12s. 4d., which has been applied by the Directors in the following manner:—After providing for debenture interest £15,000 paid and accrued, £5,000 has been carried to repairs and renewal account, and it has also

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been considered advisable to write down the preliminary expenses by £259. 2s. 8d. These deductions leave an available balance of £16,255. 9s. 8d., from which the directors propose to carry £5,600 to the debenture redemption account, and recommend the payment of a dividend for the year 1888 of 5s. per share, free of income-tax, absorbing £5,777. 5s. 0d., leaving £4,878. 4s. 8d. to be carried forward to the next year's account.

The Company's cables are in good working order, the Bolama-Bissao Cable referred to in the last report having been repaired. Since the last report, this Company has laid a cable (202 knots in length) between Bonny and Prince's Island at a cost of £24,200, which will appear in the accounts for 1889. Cables have been laid by the Eastern and South African Telegraph Company between Loanda and Cape Town, thus completing telegraphic communication along the West Coast of Africa and establishing duplicate and alternative routes to the principal stations of the Company and to the Cape. The laying of these cables adds greatly to the security of the system in point of interruption of traffic. Arrangements have been made between the companies interested for working South African traffic in friendly alliance. In view of these important matters, and the transfer to the Eastern and South African Telegraph Company of a large amount of the share capital of this Company, the Board has been reconstituted, and Sir John Pender, K.C.M.G., Sir James Anderson, and James Pender, Esq., have been appointed Directors in place of three of the former Directors who have retired. The meeting will be asked to confirm these appointments.

The Directors who retire by rotation are Sir Henry C. Mance, C.I.E., and Robert Kaye Gray, Esq., and who, being eligible, offer themselves for re-election.

The CHAIRMAN: Gentlemen, before I ask you to approve of the resolution which I shall propose, I think it right that at this, the first important meeting of this Company, I should make a few remarks, but they will be very few compared to the important work that has just been completed—probably one of the most important works that have been done in connection with submarine telegraphy. If you look at the map behind me you will see that we have virtually surrounded Africa with submarine telegraphs, and we have at the same time connected every port of that great Continent with the great system of submarine telegraphy throughout the world. That is a very great enterprise in every sense of the word—great for the future of Africa, because every one is now endeavouring to take a part in opening up what has been called "the dark Continent"—and I think that we, the submarine telegraphists, have been, as we have been on many other occasions, ahead of every other party who have been attempting to do their part in the development of that vast country. Now there can be no complaint of any want of immediate and rapid communication. To complete that work, starting from England, it has taken no less a length of cable than 18,722 nautical miles. That has not been done by one company, but by a combination of companies; but the policy of the companies over which I have had the honour to preside for so many years has been to recognise that the union of companies gives strength to the general system, and I think the result of this combination will go to prove to the shareholders, as well as to the world at large, that this has been a great work done in that direction. This union will add strength to the system, and what is better than all, I believe it will enable us to pay a very respectable dividend, which, had we all been acting apart, would have been very doubtful indeed.

Sir JAMES ANDERSON: Almost an impossibility.

The CHAIRMAN: Quite so. Some of the great submarine telegraph systems have been carrying out this great work. The Eastern Company's portion of it has been 3,687 miles, that of the Eastern and South African 5,829, that of the Brazilian Submarine 1,824, that of the West African 2,306, that of the African Direct 2,739, and that of the Spanish National 1,837 miles, making altogether 18,722 miles. It is an undertaking that has now been brought into a great system, acting under a joint arrangement and a joint purse, and I believe that the result of the policy will be satisfactory to all parties concerned. I think I may close my remarks by saying that when we conceived this policy of union there were many difficulties to overcome, but I am bound to say on the part of the different companies concerned whose interests were identical with our own—that is to say, that we might work for obtaining the best dividend—that we found them most friendly and well-disposed, and they all admitted that coming into the great chain of the system of telegraphs, having the Eastern Company at the head of it, was not a bad omen for the success of the Company. With these remarks I beg to move:—

"*That the report and accounts for the year ended 31st December, 1888, submitted to this meeting be, and they are hereby received and adopted, and that a dividend be declared payable on and after this date of 5s. per share, free of income-tax, equal to 2½ per cent. for the year.*"

Sir HENRY C. MANCE seconded the motion, which was carried unanimously.

On the motion of Sir HENRY C. MANCE, seconded by Mr. R. K. GRAY, the appointment of Sir John Pender, Sir James Anderson, and Mr. James Pender as Directors of the Company was unanimously confirmed.

The CHAIRMAN: I thank you, gentlemen, for the honour you have done me in reappointing me a Director of this Company. As you are very well aware the Company required to be reconstituted, at least the Board did to a certain extent, and while we regret the absence of the gentlemen who retire, and whose places we have taken, I think they agree fully with us that such reconstruction was necessary so as to work the combined system in perfect harmony. The next motion which I propose is

"*That Sir Henry C. Mance, C.I.E., and Robert Kaye Gray, Esq., be and they are hereby elected Directors of the Company.*"

These gentlemen were directors of the original Company, and by the reconstruction that has now taken place this is a general appointment by the shareholders.

Sir JAMES ANDERSON seconded the resolution, which was carried unanimously.

On the motion of Mr. ALEXANDER HENDERSON (a shareholder), seconded by Mr. ANDERSON (another shareholder), the auditors to the Company, Messrs. Deloitte, Dever, Griffiths and Co., were appointed at an annual remuneration of 50 guineas.

The CHAIRMAN: Allow me to say in regard to the appointment of these gentlemen to the position of auditors that they have been associated with all the other companies. Messrs. Kemp, Ford and Co. were the previous auditors to this Company, and I had an interview with the head of that firm the other day and he himself entirely approved of the change now made. It was a change that we were very adverse to making, but as there was a general reconstruction going on Mr. Kemp said to me that he thought the change a wise policy, though at the time he experienced regret at having to retire from a company which he felt was going to be a prosperous one. I replied that it could not be more painful to him than it was to us. I am glad to see a member of that firm here to-day, and I believe he will agree with me that this change has been carried out amicably and well.

Mr. WILLIS said he had been asked by Mr. Kemp to apologise for his not being able to attend the meeting.

On the motion of Mr. HENDERSON, seconded by Mr. ANDERSON, a vote of thanks was passed to the Chairman and Directors.

The CHAIRMAN: I am very pleased that that resolution has been proposed by Mr. Henderson. I think the very first transaction we had in bringing this thing about was with Mr. Henderson himself. I, therefore, feel that he had a great deal to do with this Company, and I am pleased to see him here to-day, believing, as I do, that he has now, as I have, the most perfect belief that this is the beginning of a series of meetings that will be very satisfactory to all concerned. I think we may say that we have got our foot on the ladder. It is not a large dividend that we are

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
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PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
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declaring to-day, but the arrangements we have made are such that I believe when we next meet we shall be able to declare what I may call a very respectable dividend. I beg to thank you on behalf of my colleagues and myself.

The proceedings then terminated.

NEW COMPANIES REGISTERED.

CAMBRIDGE UNIVERSITY AND TOWN ELECTRIC LIGHTING COMPANY (LIMITED).—Registered by W. T. Bowman, 2, Earl-street, Cambridge, with a capital of £50,000 in £5 shares. Object, to carry on at Cambridge the business of an electric light company. There shall not be less than three nor more than seven directors. The first to be appointed by the subscribers to the memorandum of association. Qualification, £250 stock.

THE ELECTRIC TRUST (LIMITED).—Registered by Hughes, Masterman and Rew, 59, New Broad-street, E.C., with a capital of £60,000 in £10 shares. Object, the construction, contracting for, establishment and carrying on of works, machinery and apparatus for lighting streets, &c., by electricity. There shall be, until otherwise determined, eight directors. Qualification, £2,000 stock. Remuneration, £50 each.

THE NORTHERN ELECTRIC WIRE AND CABLE MANUFACTURING COMPANY (LIMITED).—Registered by Godfrey, Rhodes, Firth and Co., 77, Chancery-lane, W.C., with a capital of £20,000 in £5 shares. Object, to carry into effect an agreement, dated June 20, made between Blakey, Emmott and Co. (Limited), and J. Duff, and to carry on the business of insulated wire and cable manufacturers. There shall not be less than three nor more than five directors, the first to be appointed by the subscribers to the Memorandum of Association. Qualification, 100 shares. Remuneration, £2. 2s. for every attendance for each director residing within 90 miles of the place of meeting, and £4. 4s. when residing more than 90 miles. Every director is also to receive £20 for every 1 per cent. of dividend above 10 per cent.

THE SERIES AND GENERAL ELECTRIC TRACTION COMPANY (LIMITED).—Registered by Norton, Rose, Norton and Co., 10, Victoria-street, S.W., with a capital of £200,000 in £1 shares. Object, to acquire the patents, property, goodwill, business, undertaking, and assets of the Series Electrical Traction Syndicate (Limited), or any part thereof, and certain patents or rights or interests therein, belonging to H. Foote and C. Von Buch. There shall not be less than four nor more than 12 directors. Qualification, 300 shares. Remuneration, chairman, £500; other directors £250 per annum.

BIRMINGHAM HOUSE-TO-HOUSE ELECTRICITY COMPANY (LIMITED).—This company was registered on the 26th ult., with a capital of £100,000, in £5 shares, 100 being founders' shares, to form centres in Birmingham, or elsewhere in the United Kingdom, at which electric power may be generated, accumulated, and distributed. The subscribers are :—

	Shares.
Robt. Hammond, 117, Bishopgate-street, electrical engineer	1
Charles Cornish, 132, Belvedere-road, Lambeth, clerk	1
James Whitehead, Heycot, Crouch-end, electrical engineer	1
T. E. Towerson, F.C.S., 1, Portland-road, Finsbury-park, analytical chemist	1
W. J. Bingham, C.E., 7, Bedford-place, W.C.	1
H. Linklater, 117, Bishopgate-street, accountant	1
H. Mann, 12, Woburn-place, Russell-square	1

The number of directors is not to be less than three, nor more than seven; qualification, £250 of share capital; the subscribers are to appoint the first, and are to act *ad interim*. The holders of the founders' shares will be entitled to elect one director, and the House-to-House Electric Light Supply Company (Limited) will also be entitled to be represented on the board. The board will be entitled to a remuneration of £500 per annum, together with one-tenth of the net profits remaining after payment of 7 per cent. upon the ordinary share capital, provided that the whole remuneration shall not exceed £1,000 per annum. The founders' shares will be entitled to one-half of the surplus profits remaining after payment of a non-cumulative dividend of 7 per cent. per annum upon the ordinary shares.

The following companies have also been registered with similar capital, &c., to the Birmingham, for carrying on electrical business in the places and districts referred to in their respective titles. The subscribers and arrangements for management are the same in each instance as in the Birmingham Company :—

Lancashire and Cheshire House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

Liverpool House-to-House Electricity Supply Company (Limited)—Capital £100,000 in £5 shares.

Manchester House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

Midland House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

South of England House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

Yorkshire House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

Scottish House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

The Irish House-to-House Electricity Company (Limited)—Capital £100,000 in £5 shares.

The Northern House-to-House Electricity Company (Limited) is also registered, and the subscribers differ only in the substitution of the name Mr. P. A. Latham, of 15, St. Helen's-place, E.C., for that of Mr. W. J. Bingham.

The Western House-to-House Electricity Company (Limited), has the same capital and subscribers as the Northern.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 28, 1889, amounted to £3,156.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this company for the month of June, 1889, amounted to £1,600, as compared with £1,690 last year.

THE EASTERN TELEGRAPH COMPANY (LIMITED).—This company announces that subject to the final audit the accounts show, after placing about £118,000 to the reserve fund, a balance available sufficient to pay at the general meeting on 18th July inst. the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the Preference Shares, less income tax, and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of income tax, on the Ordinary Shares, making with previous payments on account a total distribution of 6½ per cent. on those shares for the year ended 31st March, 1889. The traffic receipts of this company for the month of June, 1889, amounted to £44,805, as compared with £48,086 last year.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of June, 1889, amounted to £39,350, and to £41,764 in the corresponding period of 1888.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.—This company has declared an interim dividend of 12s. per share, payable on the 16th inst.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended June 28, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,017.

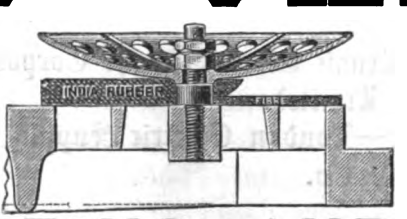
WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the month ended 30th June, 1889, amounted to £6,500.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this company for the half-month ended June 30, 1889, amounted to £2,750, as compared with £2,578 for the corresponding period last year.

THE SERIES ELECTRICAL TRACTION SYNDICATE.—This syndicate, which has demonstrated the applicability of its system to railways and tramways at Northfleet, has now been reconstituted in a larger form. Negotiations have been entered into with several leading tramway and railway companies for the adoption of the system. The company is being brought out privately under influential auspices.

NEW VALVE

No Rubber, Percha, or Leather.



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Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, July 3, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 3, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	2½%	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	54	53
2,614,820	Stock	5%	Do. Preferred	90½ 91½	4 7 5	,, ,,	91	90¾
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	19	18⅞
130,000	£10	10%	Brazilian Submarine	12⅝ 13¼	5 6 8	Mar., June, Oct., Dec.	13⅜	12⅝
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9%	Cuba Submarine	14⅜ 15½	5 18 0	February and August	15⅛	...
6,000	10	10%	Do. Preference 10%	19¾ 20¾	4 17 7	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4¼	4 4 8	March & September	3⅞	...
6,000	5	10%	Do. Preference 10%	8½ 9½	5 5 3	April and October	9⅜	...
60,710	20	3½%	Direct United States	10⅝ 10⅞	5 1 2	Jan., Apr., July, Oct.	10¼	...
880,000	10	5%	Eastern	13⅛ 13⅜	4 9 9	,, ,,	13⅜	13⅛
70,000	10	6%	Do. 6 per Cent. Preference	14⅜ 15¼	3 18 8	,, ,,	15½	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	108½	108
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	107 110	4 10 11	February & August	108⅞	...
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13 9/16	13½
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	103 105	5 14 3	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	102 105	4 15 3	January and July	104	...
179,177	10	6%	Globe Telegraph and Trust	8 8½	5 0 0	Jan., Apr., July, Oct.	8½	8 1/16
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 15	4 0 0	,, ,,	15	14⅜
150,000	10	7½% for '88	Great Northern	14½ 15½	4 16 9	Jan., July, and April	15⅞	15⅜
17,000	25	15%	Indo-European	39 41	6 1 11	April and October	...	...
9,000	8	5%	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
80,000	10	6% for '88	West Coast of America	10 10½	5 14 3	January and July	10	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2 7/16	...
34,563	10	12/0*	Do. 1st Preference 6%	11⅞ 12¼	...	April and October	12	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	6%	Western Brazilian	10¾ 11¼	6 13 4	March & September	11⅜	10⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	101½	...
			TELEPHONES.					
224,850	14/0	7%	Consolidated Telephone and Maintenance ... xd	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	4 8 3	...	...	...
80,000	5	25%	United ... xd	14½ 14¾	5 18 8	June and December	14⅝	14⅜
55,000	5	3/0	United River Plate	6 6½	...	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	...	Anglo-American Brush (£4 paid)	3⅛ 4	...	...	...	...
23,692	5	...	Do. (fully paid)	4⅛ 4¾	...	February & August	4⅛	...
79,934	5	...	Swan United (£3. 10s. paid)	3¾ 4	...	...	3 15/16	3⅞
			MISCELLANEOUS.					
37,350	12	30/0	Telegraph Construction and Maintenance	42 44	5 6 3	March and July	42½	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19½	...

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

During the last week of June, notices of intention to apply for Provisional Orders were served upon local authorities in no less than sixty-one instances, and probably some others have still to come to light. This sudden outburst of activity is, of course, due to the fact that July 1st was the latest date upon which such notices might be served in order to be immediately proceeded with. It is worthy of note that these thirty-three applications relate to only twenty-five towns—Edinburgh, for instance, having attracted six applicants; Glasgow, eight; Cheltenham and Dover, five each; Darlington, three; Birkenhead, Buxton, and Wolverhampton, two. It seems highly probable, therefore, that the Board of Trade Inspector will have his hands very full indeed for some time to come.

The most notable thing about the discussion on overhead wires in the House of Lords last Thursday week was the studious moderation of the speakers, who, notwithstanding their manifest disgust at the "gigantic nuisance," were content to recommend merely a strict regulation of its growth. The Duke of Marlborough himself suggested that the line of wires should follow the line of the street, and should not cross except at stated points. As regards electric lighting wires, Lord Balfour's announcement that the Board of Trade's regulations are on the point of being issued was deemed satisfactory; and there seemed to be a general agreement that in the case of neither of these classes of wires could the overhead system be altogether avoided.

Touching the telephone companies' amalgamation scheme, to protest against which the Duke of Marlborough's motion was primarily aimed, the formal authorisation by the shareholders had been given that same afternoon, and it was therefore little use interfering then, even if the Government could have done so effectually. It seems pretty clear, however, from the words let fall by Lord Salisbury—speaking probably for the Post-master-General—that the Government is looking forward to next Session as a crisis when the affairs of the telephone companies in relation to the Post Office may be usefully inquired into by a Parliamentary Committee.

Mr. Brand's resignation seems to have been as genuine a surprise to the shareholders as it was to the outside public. Rumour has it that the titular headship of the combined companies having been withheld from him he declined to accept any subordinate position, and consequently decided to retire altogether from the management. We can hardly credit this explanation, for Mr. Brand has been so prominently identified with the rise and progress of telephony, and with the steps which have led to the present amalgamation, that a position in it identical with that which he has so long occupied in the parent Company seems to be his of right. Any way, his retirement is to be deprecated, and we hope that it may be averted.

The telephone question in France has met, so far as the Chamber of Deputies is concerned, with a very prompt settlement. On Saturday "urgency was decreed," and on Wednesday the Chamber adopted the Bill for the purchase of the telephone lines by the State. It remains to be seen whether the shareholders of the Société Générale des Téléphones, whose bold resolution passed at a recent meeting we printed last week, will in face of the vote of the Chamber continue the fight they have commenced in the Courts of Law. The question has throughout been discussed with considerable acrimony and personal feeling, in marked contrast indeed with the courteous tone which has up to the present characterised the discussion on the same subject on this side of the channel. It is doubtless very mortifying for the shareholders to have their property summarily purchased for little more than two-thirds of what they consider its proper value; but as we have remarked before, the blame rests with those who entered into an agreement with the State capable of being interpreted in a manner so disadvantageous to the company.

As will be seen in another column, Major Marindin has advised the Board of Trade that it would not be expedient to accede to the request of the Dublin Gas Company to be allowed to exercise its power of breaking up the streets for the purpose of electric lighting. This decision is what reasonably might have been expected. It would be obviously unfair to hamper electric lighting companies proper with all manner of restrictions, and allow gas companies to enter into the business without Licence or Provisional Order. But for the fact that the Dublin Gas Company's original Act had been amended in 1883 the Corporation would probably have been obliged to contest their claim in the Law Courts. As it was, by the Act of 1883 the permission of the Board of Trade was required before the Company could exercise its powers under the 1866 Act. The right of other Gas Companies, possessing similar but unamended powers, to break up the streets for the purpose of supplying the public with "other improved means of lighting," is therefore still untouched.

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THE numerous photographs of lightning flashes which have been taken of late tend to show tolerably conclusively that lightning has by no means always the instantaneous character hitherto attributed to it. One of the earliest workers in the field of lightning photography was M. TROUVELOT, and in a short article in *La Lumière Electrique* (*vide The Electrician*, 17th August, 1888, p. 457), he insisted emphatically on the irrefragable nature of the evidence afforded by the camera as to the comparatively lengthy duration of the particular flash to which he was then referring. Subsequent examination of the photograph in question has, M. TROUVELOT states in a recent number of the *Comptes Rendus*, "clearly shown that the multiplication of the image is the result of the displacement of the apparatus while the flash lasted." It seems that a small cloud which crossed the streak of light at the lower end has been found to have undergone identically the same amount of displacement as the flash itself—a fact inconsistent with any explanation other than that the lightning flash was made up either of a number of discharges following one another in exactly the same path, or of a single flash of sensible duration.

A QUESTION, which so far as we know has not before been raised, occurred to us while watching the storm of 6th of June. Of the several hundred discharges which took place during the two or three hours the storm lasted, and of which a large proportion, so far as the eye could tell, were discharges to earth, only some five or six at the most were accounted for the next morning by the outward and visible sign of damage done. What became of the remainder? We shall, of course, be told that the rest went to earth quietly. It must, however, be remembered that a good earth is not afforded either by a slate roof or a stone pavement, yet these are interposed in towns almost everywhere in the path of a flash. This simple fact seems, therefore, to require further explanation.

M. LAGUERRE in the *Revue Internationale de l'Electricité* has proposed a new solution of the old problem of telegraphy without wires, and one which has at least some merit of novelty. Before we expound M. LAGUERRE'S idea we may offer the remark that the perfect realisation of this ideal should carry with it the inestimable boon of establishing unbroken simultaneous communication with any number of vessels at sea, however distant. We forbear to enlarge upon the ideas suggested by this visionary gleam, and will only add that in the present state of electrical science—*pace* M. LAGUERRE—its realisation seems in the highest degree improbable. We may likewise remark that in the days of PHILIP REISS the transmission of speech by electric currents was also considered in the highest degree improbable.

NOW for M. LAGUERRE'S project. If we take two insulated conductors and connect them by a wire, then on imparting a static charge to one a certain quantity of electricity traverses the connecting wire, and its passage may by suitable means be detected. Let the terrestrial globe be one of the said conductors, and as for certain reasons the moon is not available for the second conductor, let us be content with a good big sheet of metal, such as a roof of galvanised iron, well insulated from the ground, but connected therewith by a wire in which our telephone or galvanometer is interpolated. This constitutes our receiver, and if anybody anywhere, according to some preconcerted code, sufficiently varies the potential of the earth's surface we shall know of it. All this can very easily be put into mathematical language, and then, knowing the size of the earth and the smallest detectable current, we can readily calculate how much iron roof and how many volts, or rather what number of coulombs, will be required. M. LAGUERRE'S investigation yields the following results:—Assuming that the earth's surface measures 510,000,000 square kilometres, and that we can detect the passage of one-thousand-millionth of a coulomb, then with an E.M.F. of 1,000 volts at our disposal we must have an insulated conductor measuring five hectares, or 12·36 acres. We also want for transmission under the above conditions a condenser with a capacity equal to one hectare, or 2·471 acres, of surface.—It is to be feared that these statistics can scarcely be held to prove the immediate practicability of the scheme. Some improvement might possibly be effected by the use of alternating currents of Enormous Voltage—but would the Board of Trade consent? Meanwhile, we take leave to congratulate M. LAGUERRE upon a very beautiful and ingenious suggestion, though we fear that for the present ships at sea are as far away as ever.

ACCORDING to *Indian Engineering*, one of the chief items of extra expenditure on the Indo-European Government Telegraph administration for 1887-8 was the sum of £2,129 "For presents made to His Imperial Majesty the Shah of Persia and to some of his ministers on the renewal of the convention by which the British Government is allowed to maintain a telegraph line in his dominion." As nobody seems the least ashamed of the transaction, which is candidly set forth in the annual Report of the Indian Telegraph Department, we can only express our astonishment at the Shah's moderation. All the same, it is satisfactory to note that the Indian Government takes it out of him, or his subjects, for any damage done to the telegraph lines.

ONE of the most successful of the early workers in the field of arc lighting—or rather of the automatic regulation of the arc light—was the late Mr. W. E. STAITE. Unfortunately it is also acknowledged that he derived no pecuniary benefit from his labours, but sacrificed a considerable sum of money upon his devices without any return, the time not being ripe for their application. We drew attention to the facts last year, when his son, the Rev. G. H. STAITE, made an appeal on behalf of the inventor's family; and we are now informed that steps are being taken to memorialise the Government on the subject. Electricians who desire to further the object of the memorial should communicate with the reverend gentleman, whose address is Sutton-Cheney Vicarage, Hinckley, or with Colonel Hill, C.B., M.P.

AT the moment of going to press we learn that the ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION have reclaimed to the First Division of the Court of Session against the judgment of Lord TRAYNER in the Outer House, in the action by KING, BROWN and Co., Edinburgh, to reduce BRUSH'S dynamo patent.

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The Metropolitan Electric Supply Bill.—This Bill was read a second time in the House of Commons on Monday last.

Cardiff.—Formal notices were received from five electric lighting companies announcing their intention to make application for Provisional Orders.

Wednesbury.—Notices have been received of the intention of the House-to-House Electricity Company to introduce electric lighting undertakings into Wednesbury.

A Correction.—In the list of exhibitors of electrical apparatus at the forthcoming Exhibition at Bingley Hall, Mr. A. A. Goldston's name was inadvertently printed as Goldster.

Insulating Staples.—Messrs. Mosses and Mitchell, of 68-71, Chiswell-street, E.C., have been appointed sole agents for Europe and the Colonies for the sale of Mason's Safety Insulating (Fibre) Staples.

Rifle Firing by Electricity.—The War Office is experimenting with an electrical firing arrangement adopted for use with a rifle. The system has already been tried by the German and Italian Governments.

Rothesay.—At the monthly meeting of the Rothesay Town Council on Monday, an intimation was received from Messrs. Norman and Sons of their intention to apply for powers to introduce electric lighting into the town.

The Electric Light on Railways.—The Paris, Lyons and Marseilles Railway Company have just put on their lines some new first-class carriages lighted by electricity from accumulators fixed beneath the floor of the carriage.

Morecambe.—Sanction has been given by the House of Commons to a Provisional Order of the Board of Trade for the construction of a tramway to be worked by electricity, running from Scotforth, *vid* Lancaster, to Morecambe.

Ward's Electrical Omnibus.—Mr. Ratcliffe Ward and Mr. F. B. Behr have exhibited Ward's Electrical Omnibus to the Shah in the grounds of Buckingham Palace. The Shah was greatly interested in the performance of the omnibus.

The Electric Light in Collieries.—The electric light is now used at the Llay Hall Colliery, Gwersyllt, for the first time. There are 65 lights, some 16 and some 32 candle-power, lighting the pit-head, yard, crossings, offices, and workshops.

Major Marindin's Report.—A Parliamentary Paper has been issued containing Major Marindin's report on the metropolitan electric lighting schemes, and the subsequent correspondence between the Board of Trade and the London County Council.

Central Station at Montlucon (Allier).—A central lighting station of 600-light capacity has recently been inaugurated at Montlucon. The plant comprises a 60 horse-power horizontal engine and two Edison dynamos giving 180 amperes and 105 volts.

An Electric Inspector Wanted.—It will be seen by our advertisement columns that the Liverpool Corporation require an Electric Inspector at a salary of £160 per annum, the person appointed being required to devote his whole time to the duties of this office.

The Post Office Magazine "Blackfriars."—The July number of this magazine maintains its usual standard, and in point of literary workmanship is above the average. Some well-known Postal and Telegraph names are announced as contributors to the next number.

Accidental.—On taking up and repairing the recent fault in the Assab-Massowah cable, belonging to the Italian Government, it was found that the cable had been bitten by a large fish, proof of which had been left behind in the shape of one of the monster's teeth.

Foreign Contracts.—In a return recently issued of all contracts with foreigners entered into by British Government departments within the last twelve months, we notice contracts for projectors and telephones, Mangin mirrors, and various parts of the Hughes' apparatus.

Sheffield.—At the last meeting of the Sheffield Town Council a communication was received from the Electric Construction and Maintenance Company intimating intention of the company to apply to the Board of Trade for a Provisional Order to supply electricity within the district.

Willesden.—Notice has been served upon the Willesden Local Board by the House-to-House Electric Light Supply Company that they intend to apply to the Board of Trade for a Provisional Order for the supply of electric light for public and private purposes in the parish of Willesden.

Rotherham.—At the last meeting of the Rotherham Town Council the Town Clerk stated that two electric lighting companies intended to apply to the Board of Trade for Provisional Orders to supply electricity within the borough. It was agreed that the subject be referred to the General Purposes Committee.

The "Centralblatt für Electrotechnik."—Herr R. Oldenbourg, of Munich, writes to inform us that from the first issue of this journal for July it will be continued weekly instead of, as previously, fortnightly. The new series is increased in size, and is nearly as large as our contemporary the *Electrical World* of New York.

Buxton.—The Electric Construction and Maintenance Company have given notice of their intention to apply to the Board of Trade for a Provisional Order to supply electricity within the district of the Buxton Local Board of Health. A similar notice has been issued by the Municipal Electric Light and Power Corporation.

"The Gas and Water Review."—The *Gas and Water Review*, an old-established journal devoted to the interests indicated, has amended its title by the addition of the words "and *Journal of Electric Lighting*." Our contemporary announces that it will advocate the undertaking of electric lighting business by gas companies.

Dundee.—At the last meeting of the Dundee Town Council the Anglo-American Brush Corporation and the Electric Construction and Maintenance Company announced their intention of applying for Provisional Orders to supply Dundee with the electric light. A Committee was appointed to report what action should be taken.

Bournemouth.—Three companies are about to apply for Provisional Orders with a view to the introduction of the electric light at Bournemouth—the Anglo-American Brush Electric Light Corporation, the Electric Construction and Maintenance Company, and the South of England House-to-House Electricity Company.

The late Mr. Patey.—In the return of Civil List pensions for the year ended June 20th, we are glad to notice the name of Mrs. Helen Patey, who has been granted a pension of £200 in consideration of the services rendered by her late husband, Mr. C. H. B. Patey, in the improvement of the telegraph services of this country.

Hinckley Local Board.—At the last meeting of this Board the Clerk read a communication from the Midland House-to-House Electricity Company stating that it was their intention to apply to the Board of Trade for a Provisional Order, and asking the consent of the Board to the same. The matter was adjourned to the next meeting.

St. Luke's Vestry.—At the last meeting of this Vestry notices were received of application for Parliamentary powers to inaugurate electric lighting in the district from the Metropolitan Electric Supply Company, the London Electric Supply Corporation, and from a firm of solicitors in Fenchurch-street on behalf of a private enterprise.

Grantham.—At the monthly meeting of the Grantham Town Council, on Wednesday last week, a letter was read from the Birmingham House-to-House Electricity Supply Company, giving notice of their intention to apply to the Board of Trade for power to introduce the electric light into Grantham. The letter was referred to the Lighting Committee.

Newcastle.—Last week the report of the Watch Committee relative to the public lighting of the city was presented to the Town Council. Alderman Newton moved its adoption, with a rider that the Watch Committee inquire into and report to the Council on the possibility of illuminating a portion or the whole of the city by the electric light. This was agreed to.

Birkenhead.—At a meeting last week, the Town Clerk informed the Council that notices had been received from two electric lighting companies intimating their intention to apply to the

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Board of Trade for powers to supply Birkenhead with electric light. The matter was referred to the Finance Committee, who will confer with members of the Gas Committee as to the course to be adopted.

Bath.—At the last meeting of the Surveying Committee of the Bath Town Council a letter was received from the solicitor of an electric lighting company about to be formed, announcing the intention of the promoters to apply for a Provisional Order. There was some discussion as to the validity of a notice from a company which was only about to be formed, and it was finally decided not to acknowledge the receipt of the letter.

Hastings.—At a monthly meeting of this Council held on Friday last, notice was received from the Hastings and St. Leonards Electric Light Company of the intention of the Company to apply to the Board of Trade for a Provisional Order. A similar notice was received from the South of England House-to-House Electricity Supply Company. The matter was referred to the Council in Committee for consideration and report.

Manchester.—A special meeting of the Manchester City Council will be held on the 7th of August, "To take into consideration and determine upon the expediency of applying to the Board of Trade for a Provisional Order under and in accordance with the Electric Lighting Acts, 1882 and 1888, to authorise the supply of electricity by the Corporation of Manchester for public and private purposes within the City of Manchester."

Wolverhampton.—A notice has been received by the Town Council from the Wolverhampton Electric Light and Power Company intimating that the Company intend to apply to the Board of Trade for a Provisional Order authorising them to supply electricity for public and private purposes within the Borough of Wolverhampton. A notice to the same effect has also been received from the Midland House-to-House Electricity Company.

Cheltenham.—Five notices of intention to apply for Provisional Orders to provide Cheltenham with the electric light have been received by the Town Clerk. The five companies sending in these notices are the Electric Construction and Maintenance Company, the Laing, Wharton and Down Construction Syndicate, the Anglo-American Brush Corporation, the Midland House-to-House Electricity Supply Company, and a Company about to be formed.

Catalogue of the Hibbard Electric Manufacturing Company.—The first annual catalogue of the Hibbard Electric Manufacturing and Supply Company of Montreal, although by no means as exhaustive as some of those issued by similar firms in this country, contains a tolerably complete list of the lighter articles of electrical manufacture, such as batteries, bells, pushes, telephones, &c. This catalogue is got up in the artistic style which characterises these publications across the Atlantic.

The London County Council.—At the meeting of this Council on Tuesday last, the Highways Committee reported that several amendments suggested by them with reference to the Model Provisional Order proposed to be adopted with respect to areas of supply in London had been accepted by the Board of Trade. On the recommendation of the Committee the London Electric Supply Corporation were authorised to lay a cable along the subway from the south end of Northumberland-avenue to Trafalgar-square.

Darlington —At a meeting of the Darlington Town Council last week the Town Clerk stated that he had received notice from two or three electric light companies that they intended to apply for powers to light the town by electricity. Some discussion followed, from which it was elicited that the Corporation had obtained powers some time since for applying electricity if thought requisite, but the matter had not been followed up. The subject was finally referred to the Gas Committee.

Exeter.—At the last meeting of the St. Thomas (Exeter) Board of Guardians a letter was read from the Devon and Cornwall Electricity Supply Company, stating that they intended to apply to the Board of Trade for a Provisional Order authorising them to supply electricity for public and private purposes at Heavitree. The Town Council have also received notices of intention to apply for Provisional Orders from the Electric Construction and Maintenance Company and from the Devon and Cornwall Electricity Supply Company.

Perth.—At the monthly meeting of the Police Commission, held last Monday, a communication was read from the Secretary of the Scottish House-to-House Electricity Company, intimating that that company intended to apply to the Board of Trade for a Provisional Order for authority to supply electricity for lighting for public and private purposes within the city, and requesting the consent of the Commission to the application. The letter was remitted to the Police, Lighting, and Fire-Engine Committee, with instructions to bring up a report to a future meeting.

Electric Lighting Activity.—During the past few weeks Messrs. B. Verity and Sons, of Covent-garden, have been exceedingly busy in electric lighting work. Some of the most important orders they have in hand are—Sherborne House, Northleach, Gloucestershire, for Captain L. Byng, Royal Horse Guards; Foots Cray Place, Kent, for Sir John Pender, K.C.M.G.; Riverhome, Hampton Court, for Mr. Osborne O'Hagan; and the Commercial Bank of Scotland. The firm are also busy in the manufacturing departments, having secured the whole order for fittings for the Governor's house at Singapore.

Glasgow.—Notices of intention to apply for Provisional Orders for the public supply of electric light have been received by the Town Council from Messrs. Muir, Mavor and Coulson, the Scottish House-to-House Electricity Company, the Kelvinside Electricity Company, the Electric Construction and Maintenance Company, Norman and Son, the Partick, Hillhead and Maryhill Gas Company, and the Anglo-American Brush Corporation. The documents have been remitted to the Gas Committee. It will be remembered that the Glasgow Corporation itself has announced its intention to apply for a Provisional Order.

Athletic Sports.—The Electric Athletic Club, which represents the telegraphic element of the Post Office, held its annual meeting on Saturday, the 6th inst., at the Paddington Recreation Grounds. The programme included running, walking, and cycling matches, the contests for which were of the usual excellence. Mr. Fischer, the head of the Central Office, presented the prizes. The Post Office Sports are announced for the 27th inst., at the Richmond Athletic Grounds, commencing at 2:30 p m. Lady Turnor has promised to distribute the prizes, and the band of the 7th Surrey Rifles is to play during the afternoon.

Liverpool.—The Watch Committee of Liverpool had before them at their last meeting a letter giving notice of the intention of the Liverpool Electric Supply Company to apply for a Provisional Order; also notices from the following companies of their intention to apply for Provisional Orders—the Electric Construction and Maintenance Company, the Liverpool House-to-House Electricity Company. It was resolved that the Liverpool House-to-House Electricity Company should be informed that the Committee could not consider the question of giving their consent until they had been furnished with a draft of the proposed Order.

Celluvert.—We have received from Messrs. David Moseley and Sons, of Manchester, some specimens of a new substance called "celluvert." The samples before us present the appearance of very stiff, highly-glazed cardboard. Several valuable qualities are claimed for celluvert, such as great tensile strength and high insulation. It can be filed, planed, and shaped, and is but slightly affected by acids and alkalies. The material is made hard or flexible, and can be obtained in sheets, tubes, or sticks. The industrial applications of celluvert will, doubtless, prove numerous. Messrs. David Moseley and Sons are the sole agents in this country for the Celluvert Manufacturing Company of Wilmington, Del.

Dover.—At a meeting of the Dover Town Council last week the Town Clerk reported that five electric light companies—namely, the Electric Construction and Maintenance Company, the Municipal Electric Light and Power Corporation, Crompton and Co., the South of England House-to-House Electricity

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Supply Company, and the Laing, Wharton and Down Construction Syndicate—had announced their intention to apply for Provisional Orders to supply Dover with the electric light. The Town Clerk was instructed to bring up the report of the 1882 Committee, and to apply to the companies in question for particulars of their proposals.

Business Changes.—We learn that the electric business of the firm of Clarke, Chapman, Parsons and Co. has been transferred by mutual consent to the Hon. C. A. Parsons, the well-known inventor of the Turbo Electric Generator, who will now carry on the whole of their business in connection with electric lighting under the name of Parsons and Co., retaining the entire staff of the department. In addition to the turbo generator, the manufactures of this firm include slow-speed dynamos, arc lamps, projectors for the passage through the Suez Canal, for harbour entering and for war ships, and all other requisites for electric installations on land and on board ship.

Edinburgh.—On Tuesday last week the Town Clerk intimated that six different electric lighting companies had given notice of their intention to apply for Provisional Orders. These were—The Scottish Electric Supply Company, the Scottish House to-House Electricity Company, the Electricity Supply Corporation, the Electric Construction and Maintenance Company, Messrs. Crompton and Co., and the Anglo-American Brush Electric Light Corporation. The notices were remitted to the Lord Provost's Committee, and notice given of a motion remitting to the same Committee to consider the advisableness of the Corporation applying for a Provisional Order to supply electricity for the lighting of the city.

Technical Education in Nottingham.—At a special meeting of the Nottingham Town Council on Monday last week, a letter was read from the Drapers' Company in reference to the proposed extension of the University College at Nottingham by the erection of technical schools. The Drapers' Company offered to provide £3,000, conditionally on the balance of £9,000 being raised by voluntary contributions within twelve months from now. A communication from the solicitor of the late Mr. F. C. Cooper, of Nottingham, was also read, offering to transfer to the Corporation, subject to certain details being arranged, the real and personal property of the deceased gentleman, of the estimated value of £5,000, for the promotion of technical teaching at the University College. These offers were cordially accepted by the Council, and hopes were expressed that the necessary balance would soon be raised.

Hammersmith Vestry.—At the fortnightly meeting of this Vestry last week, the Law and Parliamentary Committee reported that with respect to a circular letter from the Paddington Vestry, transmitting copy of resolutions passed by them dissenting from the proposal to transfer control under the Electric Lighting Act from the Board of Trade and Vestries and District Boards to the London County Council, and inquiring the views of this Vestry thereon, they recommended that the Vestry do agree with the resolutions passed by the Paddington Vestry, and that the Board of Trade, the London County Council and Paddington Vestry be so informed. After considerable discussion the matter was referred back to the Committee for further consideration. Letters were received from the Anglo-American Brush Electric Light Corporation, the London Electric Supply Corporation, the House-to-House Electric Supply Company, the Metropolitan Electric Supply Company, and on behalf of a company about to be formed, stating that application is intended to be made to the Board of Trade for Provisional Orders, authorising them to supply electricity for public or private purposes within the parish.

The Proposed Edinburgh Exhibition.—A meeting of the Executive Committee of the proposed "International Exhibition of Electrical Engineering and Mechanical Inventions, Edinburgh, 1890," was held on Wednesday morning. The various Committees in connection with the scheme were arranged for and the conveners appointed. Among other matters considered were the choice of a general manager. The appointment of agents in London and the Continent was also considered, and it was remitted to a Sub-Committee to arrange for these. Numerous subscriptions, it is stated, have been already intimated from private individuals, and promises of support in the way of exhibits have been received from various parts of the country and the Continent. Among the latter are some important exhibits now on view in the Paris Exhibition. Mr. Edison has also agreed to place some of his inventions on view. On the same afternoon, at a meeting of the Lord Provost's Committee of the Town Council, it was resolved to recommend the Council to decline to grant the East Meadows as a site for the Exhibition. The Lord Provost's Committee at the same time resolved to recommend that the Council should vote a sum of £1,000 to the guarantee fund of the Exhibition, provided the Council were satisfied with the site and other arrangements.

Dublin.—At a meeting of the Corporation of Dublin, on Monday, the Town Clerk reported that he had been served with notices on behalf of the Irish House-to-House Electricity Company and of Colton and Company, intimating their intention of applying to the Board of Trade for a Provisional Order for private and public electric lighting in Dublin. He said the Board of Trade had forwarded the report of Major Marindin in reference to the recent inquiry, at which the Alliance and Dublin Consumers' Gas Company sought powers to open the streets for the purpose of supplying electric light to the St. Stephen's Green area. The report, which was a lengthy one, stated on the subject of capital that even if it were held that the refunded sums should be considered as old capital, which was somewhat doubtful, the amount actually available for electric lighting was only £10,000, and this sum was inadequate for an undertaking which was estimated to cost £15,882. The power to break up the streets would, if granted, place the Gas Company in a far better position than any other electric lighting company in the kingdom, and in a position which he could not think was contemplated by Parliament or the Board of Trade. In conclusion, the Inspector said:—"I have to report that, in my opinion, it is not expedient for the Board of Trade to accede to the request of the Alliance and Dublin Consumers' Gas Company, and to exercise their power under the Act of 1883 by giving permission for the breaking up of the streets by the Company for the purpose of electric lighting."

The Metropolitan Electric Lighting Orders.—On the order for the second reading of the Electric Lighting Provisional Orders (No. 2) Bill in the House of Commons, on Wednesday evening, Sir G. Campbell said he had no desire to stop the progress of these Bills; but he wished to be assured that the section of the Act of 1888 which provided that the consent of the local authority should be obtained before a Provisional Order was granted by the Board of Trade for the lighting of any district had not been forgotten. Sir M. Hicks-Beach said that the Act of last Session was properly stringent upon the point which the hon. member had raised. He thought it was a great discredit to this country that the Metropolis of this great Empire should not before this time have had the advantage of the electric light. He trusted that, while every proper interest would be safeguarded by the Committee to which these Bills would be referred, it would be found possible during this Session to deal with this matter, which might have been dealt with some time ago but for defects in the general law. The hon. member had referred to the objections of the local authorities which they had felt it their duty to overrule as if those objections had been general. That was not the case. It would appear from the special report that in only two cases in the whole of the Metropolis were objections made on any important grounds. The other objections were practically settled, and in the two cases which he had mentioned the objections were not based on matters of principle, but on matters of detail affecting clauses, which matters might be properly dealt with by the Committee. The Bill was then read a second time, as were also three other Electric Lighting Provisional Order Bills. A number of petitions in opposition to several London Electric Lighting Provisional Orders have been deposited in the House of Commons, among them being one on behalf of the Duke of Bedford and the Strand District Board against the Mid-London Order; the Wandsworth District Board of Works petition against the South London Order; the Vestries of St. John the Evangelist and St. Margaret, Westminster, petition against the Kensington and Knightsbridge Order. All the petitioners pray to be heard in Committee.

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MODES OF DAMAGE BY LIGHTNING.

BY PROF. OLIVER LODGE.

Some recent occurrences suggest that what experiment indicates to be a possibility does sometimes happen, viz., that electricity surges up from an earth contact by an underground route and causes damage without having any obvious entrance or exit to the sky. When discharge occurs to the ground, conductors, like gas pipes buried in it are so disturbed that they easily give off sparks; not sparks which will charge a Leyden jar—the electricity splashes up and subsides again in an instant,—but sparks which very readily light gas and give shocks.

This is a straightforward experimental fact. One would not, therefore, be surprised to hear of lightning producing a similar effect on a larger scale; so that, when the ground is struck, earth connections of all kinds to neighbouring houses and telegraph stations become sources of danger rather than safety, and bring up from the main flash echoes or splashes which may in some cases do damage.

Three instances, or apparent instances, of this have been reported to me recently. The first is the case of a house at

FIG. 1.

Wavertree, wherein a gas pipe was melted in an underground cellar and the gas ignited, while there was no trace of any kind indicating how the lightning had got to the cellar, except that the owner saw a fireball or glow travelling up the drive, along what turned out to be the course of the gas main. (A fuller account is subjoined.)

The second instance is that of a lighthouse in India, reported to me by Colonel Fraser, R.E., in which while flashes were striking the lightning conductor, a man was killed inside the building, though no apparent branch flash reached him from anywhere. Various explanations of this case may be suggested, and I do not press it, but quote it below.

The third case is that kindly communicated by the Electrician to the Commercial Cable Company, where instruments not connected with any line-wire or cable, but only connected to earth though the lightning protector, were completely destroyed. A record of this may be found in another part of the paper.

Returning to the first, or Wavertree case, the following is a statement by the occupier of the house, E. Lennox Peel, Esq.:—

"One stroke, A (Fig. 1), melted and twisted up 8ft. of roof-gutter round the corner, and also knocked off 2ft. of ornamental finishing, C. At first we thought this was the same stroke as the one that landed (B) in the cellar, *under* drawing-room window, D, fusing 3ft. of gas pipe, firing the gas, and scorching the cellar ceiling; but as we can find no trace of A coming *inside* the house we fancy now that we were hit twice, and that we never saw A at all from the dining-room window, E."

"There were two tremendous crashes, one of which we put down to a stroke on the church exactly opposite, the steeple, with conductor, being just opposite dining-room window, E, across road from the gate shown. At the first crash (but we now believe *before* we heard it) a ball of fire seemed to come away from the church, cross the road, rush through the gates, up the drive, and pass E as if to D. I was standing inside the window E, and saw it coming, but had to shut my eyes. There is a gas lamp opposite right-hand gate-post, and our gas pipes are laid under the drive up to B. The next crash came 30sec. later, and was probably A. Both were distinctly heard in church, as if the house had been struck twice. The steeple was surrounded by black cloud, high up, swirling round, and white vapour low down. The lightning came from every quarter, about nine flashes in less than two minutes, with very large hailstones."

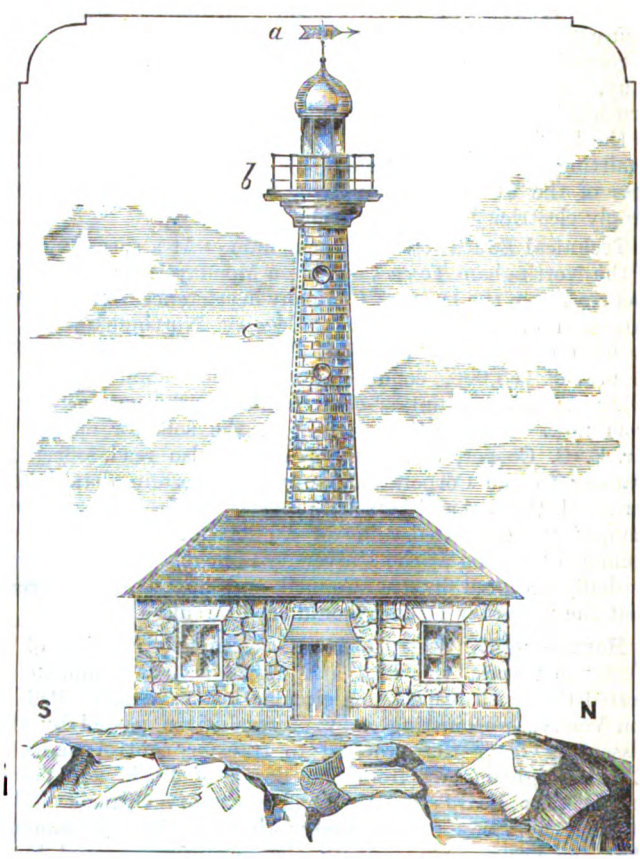

FIG. 2.—Mangatore Lighthouse.

a, copper vane; *b*, wooden railing; *c*, copper wire rope at the back of the tower.

I myself examined the premises some weeks after the event, and it is clear to me that the church was not struck, or, at least, not struck violently. If Messrs. Newall have a record of how this conductor is earthed, and would communicate it, it might perhaps be of interest. The points of its conductor are sharp, and no part of the conductor or earth shows the least trace of damage. The church steeple is lofty and its centre is only 52 yards from the house. The conductor is a copper tape by Newall, of Gateshead, and seems in excellent condition. The house is an ordinary building, not so tall as the body of the church itself; it is, therefore, entirely dwarfed by the spire, and that it should have been struck in preference to the spire is remarkable. Service was going on in the church at the time. There were seven flashes all pretty close together, and two of them were specially loud and alarming. One of them Mr. Peel believes to be connected with the damage to the roof at A; the other to the damage in the cellar at B.

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The telephone wires from church to a neighbouring house are quite thin and uninjured, and evidently have nothing to do with it. The path of the flash which struck A is not at all clear. It may have gone down a rain side-gutter and water-butt not far off, but if so it has left no trace of its passage. No connection of any kind is apparent between the two damages. And it seems to me much more likely that the second flash got into the gas pipes outside the house altogether. Several feet of pipe had been very effectually fused, but this may have been mostly done by the ignited gas which burned some time before discovered. It was ¾in. pipe—not compo—and it must have been a pretty strong disturbance to melt it.

The ball of fire seen travelling along the ground which often makes its appearance in these stories is too frequently set down to imagination, because it is not a thing to be expected on ordinary theories; but when we know so little of the phenomena, it is surely wiser to accept provisionally even incredible statements, if often repeated, and try and amend our theories by them, rather than to ignore what may turn out to be perfectly true.

It may be remembered that during some of the experiments I had the honour of showing at the Institute of Electrical Engineers, a wire conveying the discharge glowed with a luminous brush all along its length (it is an effect I have frequently obtained in the laboratory), and one of your correspondents (*The Electrician*, May 3, p. 749) wrote to ask about what he likened to a "luminous mouse" which he saw travelling along the wire, and taking an appreciable time in transit.

The *progressive* appearance is doubtless an optical effect, but the luminosity is a reality, and, since it appeared to travel then, so it may easily appear to travel when caused by lightning.

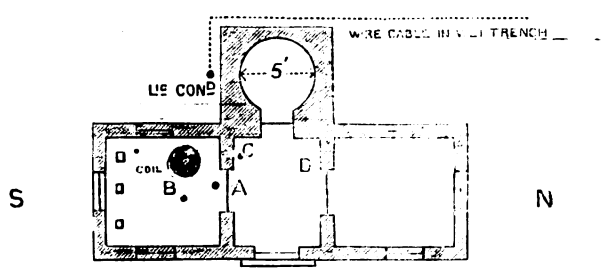

FIG. 3.—Ground Plan of Lighthouse.

A, assistant master's position; *B*, deceased, standing; *C*, inspector; *D*, two other natives.

I should suppose that the gas pipes conveying the discharge are at so high a potential that the brush from them is sometimes visible above the ground. If this be a fact, it is not one that can be regarded as at all established as yet; but this communication may direct observers' attention to the possibility both of this brush effect and also of damage being done by a charge which surges up and subsides again whence it came, without having any separate egress, or, as it has hitherto been usually expressed by observers, without any perceptible ingress to the place where the damage is done.

A fourth instance I have heard of quite recently as occurring at Harvey-road, Cambridge, where damage was done to roof and to basement, but no apparent connection or path from one to the other. I should suppose that the roof damage was done by a side-flash spitting off from the main-flash and returning to it again without finding any separate earth. It is very necessary to realise that this lateral expansion or temporary overflow may occur, so that things are momentarily charged and discharged again without their necessarily affording any thoroughfare whatever.

Perhaps Mr. Glazebrook could find time to report on this case?

The following are the communications from Colonel Fraser:—

PROF. O. J. LODGE, F.R.S. Malabar District, May 29, 1889.

Dear Sir: Having several lightning conductors to do with, and rather inclined to your expressed distrust of them, it may be of interest to mention the particulars of an occurrence at the Mangalore Lighthouse on the 14th inst. This lighthouse (Fig. 2) consists of a masonry shaft about 10ft. diameter, standing on a cubical plinth of 12ft. sides or so, with two small store-rooms having terraced roofs on the flanks. There is a passage in the plinth having an entrance door and doors at the side leading into the store-rooms, and an inner door giving admission to the base of the column which has flights of wooden ladders up to the capital on which there is a gallery and the lantern of glass and bronze.

The Public Works have lately been arranging the lightning conductor, the upper part of which down to the ground was supplied by the English makers of the lantern, and consisted of a 2in. copper wire rope fastened to the exterior of the column and its plinth.

The earth connection only remained, and as the lighthouse is on a dry rocky hill plateau, I had a cable of 49 telegraph wires made at Madras to reach down to a well to be sunk to moist earth in the valley below. When at the place last month this cable had been soldered to the copper rope and laid in an open trench more than 200ft. long to close to the well. As moist ground was not reached at the depth expected the cable was too short, and a piece of extra copper rope had to be waited for as well as the further deepening of the well. From the ground to the top of the lantern is, I suppose, about 150ft., or less.

At 7:30 p.m. a thunderstorm came on it is reported, and as heavy rain fell the trench and cable were wet for a length of more than 200ft., so that the earth connection must have been complete, notwithstanding the cable not ending in the well.

The following extract from the Post Officer's report states what happened:—"A group of natives had been sitting near the lighthouse, and all but two ran for their homes when they felt rain. These two clamoured at the closed door for admission into the lighthouse, in which two keepers had been on duty. On entering the inner room one remained standing, and the other, a youth of twenty-one years, who had lately come up from the Madras College, sat on the sill of the inner door. Before the keeper had time to close the outer door the flash came, the sitting youth fell backwards, and feebly calling for water, died almost instantaneously, his friend was struck up the legs, and was partially paralysed the next day, but afterwards got over it, and the second keeper was hurled across the room. The left arm of the keeper certainly showed marks of exterior burns. No external marks appeared on the dead man." Another account I had from my P.W. subordinate alluded to a small piece of zinc sheeting over the outer doorway as the point the lightning struck.

However, in writing to the head of the Marine Department in reply to inquiries about the lightning conductor, I quoted from your article in *Nature* of March 14 on "Leyden Jar Discharges," which I had been much interested in reading, and its footnote.

I said, in my opinion, as the force of discharge was not in the wire, but in the open air and space (water included) round it, the inside of a lighthouse was a most dangerous place to be in if a flash went through the conductor, as some of the disturbance would go through you.

It is also a question with me if a person, being of conducting material—water, &c.—themselves, they would not spark from induction, much as a piece of metal; and to what extent small masses of metal, such as door locks, watches in the pocket, &c., get charged by a lightning conductor; and there is a third element, the wetted exterior plaster in patches not necessarily continuous.

In my official letter I alluded to the radiations from an electric discharge, and that some of these may have an effect similar to sunstroke upon the human organism—so that radiation and not electricity may have caused the fatal accident.

This was evidently a very bad thunderstorm, as a tree was struck as well as the lighthouse, but the building was unaffected.

The addition of a conductor may have made it proof against being shattered, and at the same time not to be occupied without danger when there is electricity about.

I am inclined to think that the noise of thunder is the radiations made audible much in the mode of your Royal Institution experiment on the C note.—I remain, yours very faithfully,

A. T. FRASER.

PROF. O. J. LODGE, F.R.S. Calicut, June 13, 1889.

My dear Sir: After writing, I have received detailed accounts for which I called, and as no conclusions can be drawn from an inaccurate description, enclose nearly all my official letters, putting the Marine Department at Madras right in their facts.

The statements of the two educated natives, one of whom was struck, are interesting, but contain so little more than I have extracted that I do not trouble you with them.

The lightning conductor evidently was acting, and is said to have been struck twice, as well as a tree three or four hundred yards away.

I find the lighthouse rooms are tiled, not terraced. It is possible they were terraced within my recollection, as the present tiles are certainly new. An amended sketch is enclosed.

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There is a sheet zinc hood 4½ft. by 3ft. over the front door, and there were 23 of the patent clay tiles, each 6½lb. weight, blown away at the eaves just above the hood.—I am, yours very faithfully,

A. T. FRASER.

Extract from official letter June 12, 1889, embodying the narrative of two native eye witnesses in Mangalore Lighthouse on May 14 when struck by lightning, to correct the first account sent to the Marine Department, Madras.

1. The detailed account of Inspector Ram Rao, one of those in the Mangalore Lighthouse during the thunderstorm of 14th May, differs in some particulars from the information the Post-Officer was able to obtain and communicate.

2. Including the keeper, there were ten natives inside the basement, seven in the passage, two in the south room, and one upon its doorway or sill (Fig. 3).

3. The inspector was on a seat in the passage, near the door leading to the column, which was closed. The front (outer door) was also shut and bolted.

4. The first thing he observed was a "spark"—no flash struck anywhere—on the ground before him about a foot and a-half from his seat. No lightning was seen by him to come through the front door. The electricity was on the floor of the passage, not far from the door of the column.

5. Assistant-master Narani Rao, Government College, also gives an account of what he saw happen, he being on the door sill.

6. He says two people in the passage suddenly saw a light creeping on the floor near their feet, and about the same moment a long spark in the south room; two saw the luminous body on the floor, and two the spark in the room, but only one saw both.

7. Simultaneously with the latter, the narrator and the native who died both dropped on the ground. His impression was that a current of electricity was flowing from his feet to his head, and he soon recovered. He is satisfied that the current did not come through the front door. Singularly enough, the deceased was talking to him about lightning conductors, and asked if his keys were likely to attract it, just before he was struck, without noticing he was standing close to a large coil of wire.

8. Those who saw the spark in the room are positive it was not parallel to the floor. One thinks it was perpendicular, and the other slightly inclined to the lightning conductor outside.

9. It seems there was a coil of 94ft. of galvanised iron fencing wire lying in the corner of the south room, some 5ft. in direct distance from the conductor outside with the wall between.

10. I would be inclined to attribute one of the individuals being fatally struck to his standing near this loose metal, and there were also some kerosene tins in the room, all either inductive or conductive surfaces.

11. But I have to notice that, strictly speaking, none of them had a right to be admitted into the lighthouse on the occasion, and it was, unluckily, one of the worst places they could have chosen in which to take refuge, and there is no system of lighting conductors, which, in my opinion, can make it safe.—A. T. F.

SINGULAR CASE OF DAMAGE FROM LIGHTNING AT A CABLE STATION.

During a severe storm at Canso, N.S., the Commercial Cable Company's instrument-room was recently traversed by a discharge which severely damaged the apparatus, and this, notwithstanding the fact that the earth connections had been broken. The details were carefully recorded by the company's officers, as will be gathered from the following letters, in which the circumstances are fully set forth. The first letter is addressed by Mr. Gott (the chief electrician of the Commercial Cable Company) to Dr. Oliver Lodge, to whom, with Mr. Gott's approval, we are now indebted for its appearance in our columns. We may hazard the suggestion that the damage was due to a "side-flash" from the conductor to the recorder rather than to the main flash striking the recorder first and then jumping to the conductor, as suggested by Mr. Gott. But Dr. Lodge will, we hope, express his own opinion on this point.

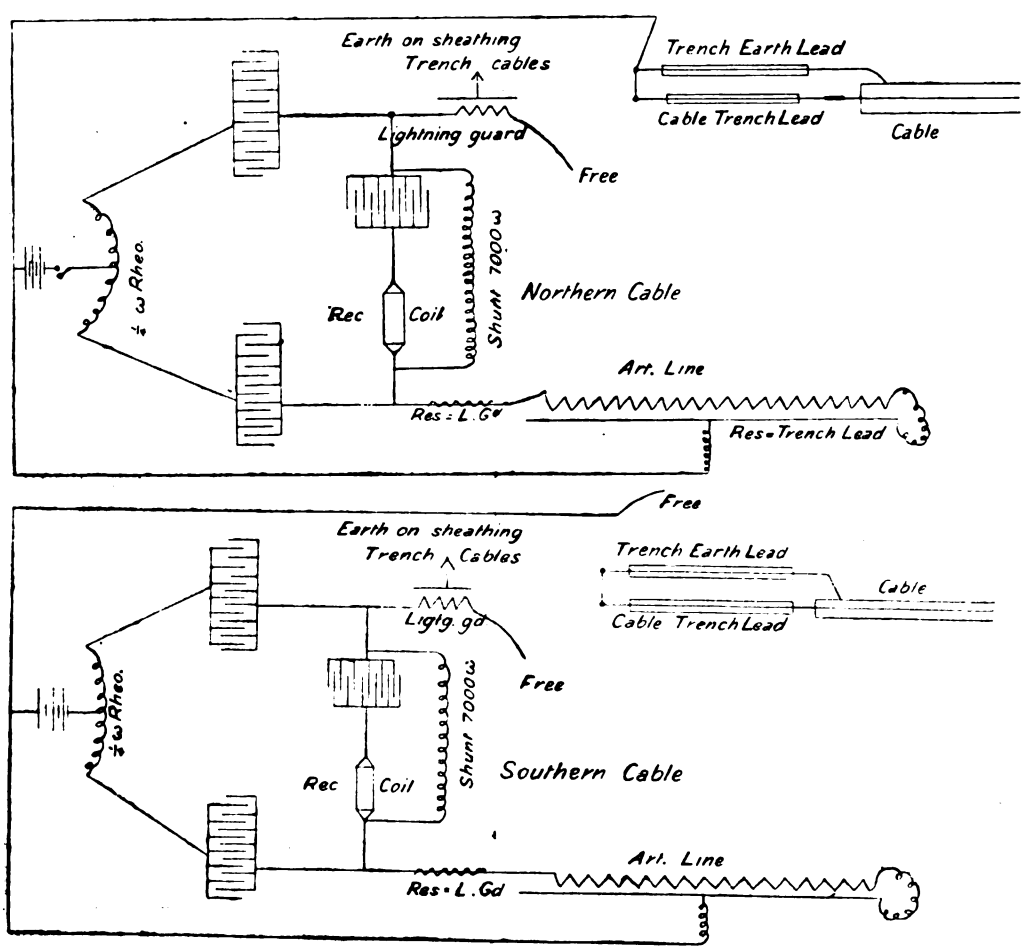

FIG. 1.

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16, Mark-lane, London,

PROF. O. LODGE, June 18, 1889.

Dear Sir,—Perhaps you will be interested to see the enclosed report from our superintendent, Mr. Dickenson, at our station at Canso, N.S.

That station was visited by a severe thunderstorm on the 14th of May last, and serious damage was done to the apparatus employed on our northern and southern Atlantic cables. The cables were disconnected from the apparatus and put to earth before the storm.

In the case of the northern cable, the artificial cable was connected by its earth side to the trench wire, which makes earth at the cable house about four knots from the station. This trench wire is in reality a cable with iron wire sheathing, and passes through wet land; or, in other words, the sheathing makes good earth all the way.

In the case of the southern cable the apparatus was entirely cut off from all lines, the only earth in its immediate vicinity being that of the lightning protector.

The Thomson permanent magnet recorder is used on both cables, and in both cases the movable coil was fused and the condensers were damaged.

My own opinion at present is that the lightning struck direct at the large mass of metal of which the recorder is composed, and from these made for the lightning protector. Had there been no lightning protector it is probable the apparatus would have been spared.

This is a well-certified instance of telegraph apparatus being damaged when entirely disconnected from the line, and also one proving that the lightning protector *may* do more harm than good.—I am yours faithfully,

J. GOTT,
Electrician Commercial Cable Company.

Canso,

JOHN GOTT, ESQ. 25th May, 1889.

Dear Sir: I herewith enclose diagram (Fig. 1) showing position of affairs when apparatus was damaged by lightning on the 14th inst. I

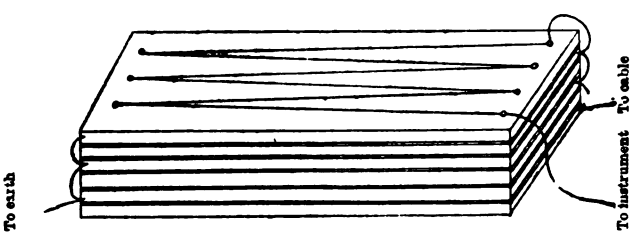


FIG. 2.

was absent from the station at the time, and did not return until four or five hours after damage was done, but careful inquiries lead me to believe that the positions of leads as indicated in diagram are correct. The earth lead was inadvertently left on the northern apparatus, providing a possible path for discharge through the apparatus to lightning guard, and thence to sheathing earth; but no such path appears to have been provided in the case of the southern, which sustained equal damage with the northern.

On the northern, signalling coil and lightning guard were fused, a one-microfarad section of condensers in cable sending block destroyed (short-circuited), and a five-microfarad section artificial line block damaged. Insulation reduced to 15,000 ohms.

On the southern, signalling coil and lightning guard were also fused, and two ten-microfarad sections of cable-block destroyed.

The fine platinum wires in lightning guards were entirely dissipated.

Owing to violent kicks cables were earthed as per accompanying diagram ten minutes before thunderstorm broke over the station.

The lightning guards consist of a fine platinum-wire of about 35 ohms resistance, and a series of thin brass plates separated by mica sheets and alternately connected with cable and sheathing of trench cable (Fig. 2).

The lightning which did the damage appears to have been very close to the station, as the men tell me that the flash and thunder were almost simultaneous. There are somewhat sensational accounts given by some of the men who claim that an electrical discharge seemed to dart across the operating room from one side to the other. My opinion is that they were deceived consequent upon the intense light caused by fusing of coils.

No damage whatever was done on short cable circuits, which were all treated in same way as northern and southern.—Yours truly,

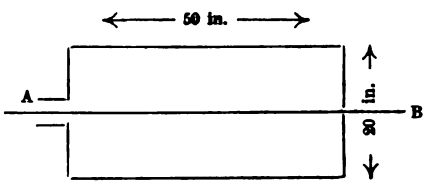
S. S. DICKENSON,
Superintendent.

EXAMINATION PAPER OF THE SCHOOL OF ELECTRICAL ENGINEERING AND SUBMARINE TELEGRAPHY.

At the recent Midsummer Examinations connected with the well-known school in Hanover-square, the following Paper was set for the advanced students; the examiner in electrical engineering being Mr. Gisbert Kapp:—

At least five questions to be answered, but more if possible.

1. A rectangular wire coil of the dimensions shown, and mounted upon an axis, A B, is revolved at a speed of 10 revolutions per second in a uniform magnetic field of 1,000 C.-G.-S. lines per square centimetre. The lines of the



field are at right angles to the plane of the paper. The coil contains only one turn of wire Give the E.M.F. generated when the plane of the coil is at right angles to the lines, when it forms an angle of 45deg., and when it is parallel with the lines. Give the law according to which the E.M.F. varies with the angular position of the coil.

2. A disc machine, gramme-wound, is revolved at 800 revolutions per minute in a 4-pole field. The armature contains 312 turns of wire, and the total number of useful magnetic lines coming out of, or entering into, each of the four-poles is 3,000,000 C.-G.-S. lines (500 English lines). There are four brushes, opposite brushes being coupled together. What E.M.F. will be generated, and what would be the E.M.F. if the same armature were revolved in a 2-pole field, the useful induction of each pole being also 3,000,000 C.-G.-S. lines?

3. What do you understand by (*a*) the ordinary (or external) characteristic of a series machine; (*b*) its total (or internal) characteristic; (*c*) its characteristic of magnetisation; (*d*) its critical speed for a given total resistance; (*e*) its critical total resistance for a given speed? Explain the critical speed in a shunt machine.

4. Explain a method by which the characteristics of a dynamo can be predetermined from its design.

5. A motor (shunt-wound) runs, when doing no work, at 700 revolutions per minute. Its armature has a resistance of ·085 ohm, the field-magnet has a resistance of 25 ohms. The motor receives current from a pair of mains, between which a terminal E.M.F. of 100 volts is maintained—What will be the speed and electrical efficiency when the motor is giving 5 horse-power and when it is giving 9 horse-power? Assume, for the sake of simplicity, that there are no other besides the purely electrical losses—in other words, that the electrical efficiency and the commercial efficiency are equal.

6. Describe and illustrate by hand-sketches various machines used for incandescent lighting (not high-tension arc light machines) having armatures of the closed coil type and of flat ring or disc form, cylinder or Gramme-form, and drum form. Compare the relative merits of the different machines as regards such points as weight, speed, efficiency, and mechanical strength?

7. Describe and illustrate by hand-sketches the Thomson-Houston high-tension arc light machine, and explain its working?

8. You have to transmit 40 horse-power over a distance of 1,000 yards. At the generating station there is to be one series-wound machine driven at a constant speed, and this must give sufficient output that, after allowing for losses in transmission and in the motor, 40 horse-power may be actually available. The motor is also series-wound. What current and E.M.F. would you adopt? What should be the size of the conductor? What type of dynamo and motor would you adopt?—and what must be the relation between them in order to cause the motor to run at a constant speed though the load is varied? Give approximately constructive data of generator and motor. (The answer to the last question is optional).

9. You have to light a country house in which there will be 200 60-watt, 25 100-watt lamps and 4 9-ampere arcs. All the lamps may be required for five consecutive hours. A storage battery is to be used which must be capable of supplying the whole current required; the battery to be charged during the day, charging time five hours. Give size of dynamo and battery, and describe in general terms how you would arrange the installation?

Coast Communication: Tory Island.—The delay which has taken place in connecting by cable the lighthouse and signalling station on Tory Island with the Irish land lines is caused by the failure of negotiations between Lloyd's and the proprietor of the island for the purchase of the necessary land. Sir M. Hicks-Beach stated on Tuesday evening that probably Lloyd's would now proceed under the compulsory powers granted by the Act of last Session.

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And the issue for 1890, which will be still further enlarged and improved, is in preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded to the Publishing Office, 1, Salisbury-court, Fleet-street, London, E.C.

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AMERICA AND SUBMARINE CABLES.

Our correspondent in New York and the technical journals of that city have lately announced some unusual activity in cable laying projects more or less directly connected with the United States; and we are asked to believe that much anxiety is felt in that country lest all the contracts for manufacturing the required cables should be, as usual, appropriated by British firms. Without attaching too much meaning to newspaper phrases, which may represent merely the disappointment of financiers, or possibly only the absence of something better to talk about, we can quite understand American electrical engineers being rather exercised in their minds in the face of opportunities such as those referred to, which occur but seldom, and which being missed are never likely to occur again. The matter is of no great importance to us, and British submarine cable manufacturers will look on with equanimity at any attempt on the part of America to compete with them in an industry which they have made peculiarly their own. To English electrical engineers generally, however, the subject is of some interest as showing that their own complaints—much exaggerated as we believe—against American competition find their counterpart on American soil, where we are roundly charged with greedily monopolising the cable trade of the whole world.

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People seldom resent the language of envy, and probably the Americans are as indifferent to our complaints as we are to theirs when national aptitudes or fortunate accident has determined the home of a particular industry. When all the facts are known the explanation is not only simple but natural; and as regards submarine cable making and submarine cable laying we can confidently say that their nationality is far more easily explained than is that of some other important industries which continue to be peculiarly American. It was England that first wanted cables to connect her with the neighbouring shores of the European continent. She required them also as a link between herself and the Sister Isle, to say nothing of the less important fragments of the kingdom like the Isle of Wight—all of which afforded excellent means of testing the possibilities of submarine telegraphy. Gradually the operations were vastly extended, but always from our own shores; and by the time the demand for cables arose in other countries the manufacture was firmly established here. A seafaring nation naturally possesses great advantages in the operations of cable laying and repairing, and pre-eminence in this respect has doubtless contributed to our retaining the cable industry from beginning to end. Other causes, which we need not dwell upon here, have tended in the same direction; but, broadly, it is sufficient to say that nobody needed cables so much as we, nobody could make or lay them so well as we, and that, consequently, nobody else has found it worth while to compete with us.

The character of the industry is extremely technical, and has been built up by wide and varied experience among the very few firms who exclusively practise it in this country. And that those firms are so few is proof that their business is not lightly to be competed with. Enormous capital is embarked in these cables, and to sink it at the bottom of the sea without the guarantee of reputable and competent makers is not a proceeding which commends itself to capitalists of this country, and we should imagine not to those of America. The well-known English firms have since 1850 made and submerged almost every mile of telegraph cable that has so far been required, and it would surprise us, though it would not vex us in the least, if they do not for many years to come continue to command the confidence which their knowledge and enterprise have earned. Probably they are fully alive to the projects which are announced from the other side of the Atlantic. To say nothing of the Pacific cable which is yet in the embryo stage, there are the United States and Brazilian cable, a Chilian cable to the Straits of Magellan, a German cable to Portland, Maine, besides some Canadian cables, and the Halifax-Bermudas cable which has already fallen to an English firm. Of the rest, there seems still to be some uncertainty as to who will get the contracts; and the profits are supposed to be so attractive that electrical engineers in America are being spurred to stretch a hand for them or be branded as "unpatriotic" and spiritless idlers.

We have been unable to discover any better or more substantial reasons than these for the gratuitous advice offered by Mr. Herbert Laws Webb and other writers who talk fluently on the subject to American electricians. Perhaps we ought to except Mr. Webb's disparaging remarks about the Thames, which, as all the world knows, is less convenient for cable ships and cable factories than the docks of New York; and of course there are no docks in the Thames. But beyond these notable inducements which Mr. Webb calls facts, he has nothing to rely upon but the *amour propre* of his audience. They are "first in the universe" with all other branches of electrical engineering, and why should they lag behind England in the matter of deep-sea cable laying? "In a modest way" he points out that they could do as well as the Britishers if the Americans were not so shy about it; and unlike the man who was asked if he could play the fiddle, he answers, not that "he does not know, because he never tried," but that they only think they cannot do it because they will not try. Well, we have too much regard for our American friends to advise them or wish them to try, although we certainly should not begrudge them their well deserved reward if they succeeded. But they had better keep Mr. Webb's hand off the tenders. It will never do to set forth in black and white: "This is our first attempt; we want you to let us try what we can do; and if we can't secure the contract on these terms, we are prepared to lump down a heap of patriotism by way of guarantee." We repeat, this will not do at all.

REVIEWS.

Physical Memoirs, Selected and Translated from Foreign Sources under the direction of the Physical Society of London. Vol. I. Part I. (Messrs. Taylor and Francis, 1888.)

(Concluded from page 217.)

(SECOND NOTICE.)

Continuing our notice of Prof. Helmholtz's Paper on "Electric Boundary Layers," the author next considers the electrical phenomena arising from the flow of liquids past a solid wall, which is wetted by them. Prof. Quincke has investigated the E.M.F. produced by the motion of the liquid, and also the transfer of liquid produced by the passage of the current, and his results have been confirmed by the researches of J. Elster (Wiedemann's *Annalen*, Vol. VI., p. 553, 1879). The author explains these phenomena as follows:—"The liquid," he supposes, "stands in galvanic opposition to the walls of the tube, and the two build up an electric double layer along their bounding surface. The portion of this layer falling within the fluid is in general—omitting the exceptions pointed out by G. Quincke—positive. It is of extremely small though not of vanishing thickness. The side of this layer turned towards the bounding surface, at least in those cases in which the experimentally-found laws hold, clings immovably to the wall; the remainder can be displaced, subject however to the internal friction of the liquid. If an electric current be led through the liquid, producing a fall of potential, and therefore ponderomotive electric forces able to act on the electrically-charged parts, these forces drive along the positively-charged wall-layer of liquid. It results, however, from the internal friction of the liquid that the whole cross-section of the tube takes up the same state of motion if no hydraulic back-pressure prevent it. If there be any such, the motion of the liquid due to the pressure adds itself on to that produced by the forces of electric attraction. If the pressure drives just as much liquid backwards through any cross-section as the electric force drives forwards, a stationary condition of the liquid is set up in which the flow along the walls of the tube takes place in the direction of the electric force, but in the centre in that of the hydrostatic pressure. If, on the other hand, no external E.M.F. acts on the tube, but a hydrostatic pressure which propels primarily the water, then also the inner parts of the electrically-charged boundary layer of the liquid will be carried along at the same time. So long as this is displaced parallel to the wall of the tube with uniform velocity, and therefore remains continuously under the influence of the galvanic forces, its electrical equilibrium is not disturbed. Outside the exit end of the tube, however, it is either torn away from the wall by vortex motion, or, if it remain thereon, is forced into a thicker layer by the diminished stream velocity. By both processes its positive charge is liberated from the restraining influence of the negative layer on the wall, and becomes free. Conversely, at the beginning of the tube fresh layers are

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approaching the wall, and since the latter already possesses a negative charge, the approaching liquid must withdraw from the rest its positive electricity, and leave negative therein. The negative electricity accumulated before the entrance of the tube, and the positive electricity collected beyond the end, compensate each other again, partly through the liquid column in the tube, partly through any other conducting path offered them. In such a conductor, therefore, a galvanic current will show itself. If there be no other conducting path, the potential difference between the ends of the tube must increase until as much electricity flows back by conduction along the tube as is driven forward with the water particles by convection. This explanation agrees in its essential outlines with that given by Professor Quincke. The author then goes on to consider mathematically the transport of fluid by the electric current, the rise of pressure due to electric diffusion, the transport of water by the discharges of Leyden jars, and the transport of electricity by a flowing liquid.

The rest of the Papers contained in the present number are devoted to the establishment, mathematically and experimentally, of certain thermo-dynamical theorems founded upon the second axiom of the mechanical theory of heat. In the experimental investigation it was necessary to find some chemical change capable of being applied in at least two ways to an exactly measurable and reversible production of work. This is possible in the case of change of concentration of a solution, and this change may be brought about by evaporation, by condensation of vapour, or by electrolysis. James Moser, in a series of investigations undertaken with a view of testing the author's theory, and described in Vols. III. and XIV. of Wiedemann's *Annalen*, has shown that the difference of E.M.F. in galvanic elements brought about by differences in the concentration of the salt solutions employed as electrolytes can be calculated thermodynamically from the vapour pressures of the solutions. The result, however, depends essentially on the velocity with which the electric transportation of the different constituents in the fluid proceeds. This introduces a considerable difficulty, as to calculate its effect on the result requires an elaborate series of measurements which have only been carried out in a few cases. The difficulty, however, may be eliminated by making use of galvanic elements with one fluid and an insoluble depolarising substance, such as those of Leclanché, Pincus, Warren de la Rue, Latimer Clarke, and others.

In his third Paper the author states that in writing the earlier Papers he had found that Lord Rayleigh, in a lecture delivered at the Royal Institution on March 5th, 1875, laid down for the first time the general principle that the evolution of heat alone is not conclusive as to a possibility of a chemical change taking place in a given direction, but that change can occur only in the case in which the entropy, or dissipation of energy, increases, or at any rate does not diminish. F. Braun, in 1878, had already pointed out, and demonstrated experimentally, that the development of heat taken by itself is not sufficient to determine the magnitude of the E.M.F. of a cell. The author mentions that the great simplification produced in the thermodynamic laws by expressing the energy and entropy of a system as differential coefficients of an integral function was discovered before him by F. Massieu, in 1887 (Wiedemann's *Annalen*, Vols. V., XVI., and XVII.), and completely expressed, at any rate for two variables, though without reference to chemical processes. He also alludes to J. Willard Gibbs' important Paper on "The Equilibrium of Heterogeneous Substances" (American *Journal of Science*, Vol. XVI., 1878), in which the thermo-dynamical conditions of molecular and chemical processes in systems of bodies, consisting of mixtures of compounds of any number of different substances, have been analytically developed in a very comprehensive and general manner. These deductions from thermodynamics are of special importance for the theory of galvanic polarisation, since it is clear that the excess of the free energy of the mixed electrolytic gases above that of water depends to a great extent on the pressure, while the development of heat during their combination is nearly independent of it. So long as it was supposed that the E.M.F. of polarisation was to be deduced from the heat evolved (as the author himself had done in his earlier Papers) the E.M.F. had to be looked upon as very nearly constant, which made certain phenomena of the polarisation of a voltameter almost inexplicable, but if it be deduced from the free energy, it is obviously variable in the highest degree according to the saturation with gas of the liquid layers which lie close to the electrodes. Thus the explanation of a great part of the phenomena of polarisation is modified and most of what was before unintelligible is now made clear.

As the author's attempts to explain the processes going on in galvanic polarisation are scattered through a long series of Papers, and some of them require modification to bring them into agreement with his present point of view, he recapitulates the chief points, and we cannot do better in view of its value and importance than to reproduce this recapitulation in the author's words: "The fundamental assumptions," he says, "from which I have always started are the law of the conservation of energy and the rigid applicability of Faraday's law of electrolysis. In accordance with the latter I maintain that electricity can pass from the liquid to the electrodes only on the condition that an equivalent amount of chemical decomposition occurs, and that unless the work necessary for the dissociation of the chemical compound can be supplied by the electric forces present, this transfer cannot take place, but the bounding surface acts like a layer of perfectly insulating material.

"If the two electrodes of a voltameter be charged and maintained at different potentials, electric forces corresponding to the slope of potential act within the fluid driving $+E$ to the cathode, $-E$ to the anode. This movement of electricity never takes place so far as we know without a simultaneous motion of the ions of the electrolyte, to which the $+E$ and $-E$ set in motion are attached. Positively-charged hydrogen ($H+$, $H+$) passes, therefore, to the negatively-charged cathode, and negatively-charged oxygen ($-O-$) to the positively charged anode. If subsequently evolution of gas takes place, the gases evolved are electrically neutral. Accordingly, if the principle of Faraday's law be consistently applied to this instance the evolved hydrogen must be ($H+$, $H-$), and the liberated oxygen must either be ($-O-$, $+O+$), or ($-O+$). Since the molecule of evolved oxygen consists of either two or (ozone) three atoms, I consider the first form the more probable. Ozone would be ($-O-$, $+O-$, $+O+$). The accumulation thus produced of ($H+$) at the negatively-charged cathode and of ($-O-$) at the positively-charged anode is indicated by the "condensation current" which enters the electrodes while undergoing polarisation. In this case the two electrode surfaces behave like two condenser plates of enormous capacity, owing to the extraordinarily small, *i.e.*, only molecular, distance apart of the oppositely-charged layers. If after removing the battery the two electrodes are joined by a simple conducting wire, the two condensers are discharged back through the wire, thus giving the depolarising current. To the electrical movement thus set up, which does not extend beyond the boundary of the liquid conductor, the chemical forces within the liquid appear to offer no resistance, since under the influence of electromotive forces electrolytic conductors assume a condition of electrostatic equilibrium quite as completely as metals. This is proved to a high degree of accuracy by Sir W. Thomson's water-dropping collector, in which the weakest E.M.F.s are able to charge the separating water-drops to a condition of perfect electrostatic equilibrium. In decomposing cells, freed as completely as possible from air, I have myself succeeded in following out the proportionality between the E.M.F. and the amount of condensed charge—a proportion easily demonstrated for very small E.M.F.s—down to E.M.F.s of 0·0001 Daniell. On the other hand, the transfer of electricity from the charged ions of the boundary layer to the metal obviously takes place subject to the resistance of the chemical forces. It is the electrical discharging of the ions which definitely ruptures the chemical combination; so long as they are not discharged they can still return from the accumulated mass of atoms in the boundary layer, and assume their previous state of combination without any evolution of heat taking place, provided that the diminution in the electrical attractions which retain them at the electrodes be slow. This leads to the conclusion that the greatest and most essential part of chemical force, that, namely, which holds together really typical com-

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pounds, is based on the different attractions of elementary substances for the two electricities. Faraday's law compels us therefore to assume that each valency of every element is always charged with one whole equivalent either of positive or of negative electricity, and that the magnitude of these equivalents of electricity is independent of the nature of the substance to which they are attached, just as the atomic weights of the several elements are independent of the combinations into which they enter; just as if electricity were itself divided into atoms. That the electric forces which we have here to consider are not by any means too small to yield the great quantities of work evolved in chemical separations and re-combinations is obvious, if the enormous amount of equivalents of electricity accumulated by this process be considered. My calculation given in the Faraday lecture proves that if the +E attached to the atoms of a milligramme of water could be transferred without loss to a sphere, and the −E to another sphere at a distance of one kilometre, the two spheres would attract each other with a force equal to a weight of 26,800 kilogrammes. It is precisely in consequence of the enormous magnitude of these atomic charges that the relatively weak forces of attraction which one or two Daniell's cells can exert are competent to produce so comparatively large an amount of work. These forces are weak only in relation to the small quantities of free electricity yielded by our electrical machines. The formation of the electric double layers necessary for the setting up of electrical equilibrium explains a large and important part of the process going on in polarisation, viz., the strong initial current during the charge and discharge of the electrodes. These currents can be made of sensibly greater duration if simultaneous occlusion of one or both gases in the metal of the electrodes takes place. But neither of these two processes explains the unlimited duration of the current with feeble E.M.F.s. In my Paper of the year 1873 I showed that the gases, especially atmospheric oxygen, dissolved in the liquid electrolyte, exert the very greatest influence on the strength of the continuous current, and I explained the origin of the currents depending thereon, viz., the convection currents. In this case we have to bear in mind that electrically neutral gases dissolved in the liquid are not subject to the action of the charged electrodes in the same way as the charged ions before their discharge, but can diffuse freely through the liquid. If we now assume a stronger attraction on the part of oxygen for negative electricity, neutral oxygen in solution will be able to saturate itself with −E at the negatively-charged cathode without resistance, or may even [in doing so] contribute positive work towards the maintenance of the current, and may then either unite with (H+. H+) or set out on a new migration towards the anode, while at the same time a molecule of (−O−) becomes neutral at the anode. The whole work done by the battery consists then only in this: that neutral oxygen dissolved at the cathode in a part of the liquid poor in oxygen disappears as such, takes up a negative charge, and becomes a constituent of water, while at the anode the anion of water becomes neutral dissolved oxygen, but passes into a part of the liquid rich in oxygen. A stationary current is possible so long as the same quantity of dissolved oxygen is brought back by diffusion from the anode to the cathode as is carried as anion by the current from the cathode to the anode."

The author affirms that we may always convince ourselves that it is impossible for the fluid to attain a condition such that a galvanometer would not show a continuous current for an E.MF. less than that of a single Daniell. The galvanometer employed by the author gave a deflection of the scale-division for a current strength of 10·9 ampere, a current which would require 334 years to decompose 1 milligram of water, and if only 1 cubic centimetre (0·0005 millimetre) of oxyhydrogen gas at 0·760 millimetre were dissolved in the water, its constituents would have only to migrate once in 36 days from the anode to the cathode in order to give the observed current. Similarly, it became evident that even in cells freed as completely as possible from air, the polarisation had not reached its highest limit when the evolution of bubbles of gas began, and when, therefore, the E.M.F. of the battery had become great enough to overcome the resistance of the chemical forces. The counter-E.M.F. of polarisation, on the other hand, always increased with the E.M.F. of the polarising battery, even though the gas had been briskly evolved for some time. The author states also that for values of the E.M.F. which lie near to the limiting value corresponding to evolution of gas nothing in the behaviour of the current is observed which would suggest any sudden overpowering of the chemical forces by the E.M.F. The thermodynamical theory, he points out, offers a satisfactory way out of this difficulty, for it shows that if the gases formed are dissolved in the liquid electrolyte, the resistance due to the chemical forces which the current has to overcome must become continually greater and greater as more of the evolved gas enters into the solution round about the electrodes, and that the part contributed by the gas to this resistance is by no means inconsiderable, but may attain any conceivable value between 0 and ∞.

In the last Paper, viz., No. 5, the author points out that the investigations contained in the three Papers on "The Thermo-Dynamics of Chemical Processes" lead to the result, important for the doctrine of polarisation, that electrolytic decomposition of water can be brought about by E.M.F.s which may be smaller the smaller the quantities of hydrogen and oxygen that exist dissolved in the neighbourhood of the electrodes, so that, in fact, no other limit than zero can be assigned for the smallest E.M.F. capable of decomposing water that is perfectly free from gas. At the same time he observes that the quantities of explosive gas evolved for E.M.F.s which amount to less than 1·5 volt are so extraordinarily small that they can be perceived in no other way than by the weak residual currents which they maintain. Moreover, he showed previously that in water which originally was completely free from gases even the weakest E.M.F. is capable of maintaining a permanent electric current through the liquid; for the smallest quantity of gas which at the electrodes has become free and electrically neutral will penetrate little by little by the process of diffusion to the opposite electrode, and will thereby set free a fresh quantity of a polarising current in the direction of the battery current. Chemically recognisable quantities of dissolved oxygen and hydrogen must act incomparably more strongly. The rest of the Paper is mainly devoted to the experimental determination of the minimum limits of E.M.F. required to develop fresh gas under a given pressure of oxyhydrogen gas upon the liquid.

THE ELECTRIC LIGHTING OF THE PARIS BOULEVARDS.*

The rapidity with which the electric lighting of the Paris Boulevards was carried out, involving, as the work did, the construction of a complete system of subways and conduits and the laying of several miles of underground mains, was due to the

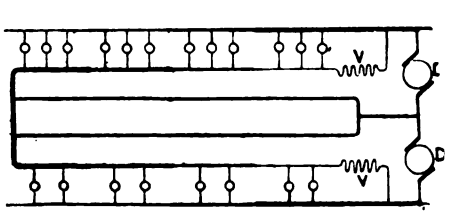

Fig. 1.

fact that the contracting companies had their plans already prepared and their central stations already in operation. Had this not been the case it is possible that even now the light would not have been available. The three companies undertaking the work are the Compagnie Edison, the Compagnie pour la Transmission de la Force par l'Électricité, and the Compagnie Française de l'Air Comprimé.

The Compagnie Edison have the lighting of the Grands Boulevards from the Porte St. Denis to the Opera House, and they have put up 34 10-ampere improved Pilsen arc

* Abstracted from *La Lumiere Électrique.*

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lamps, which are mounted on handsome bronze posts seven metres high. Of these lamps 30 are placed in the middle of the roadway, and four are grouped together on a refuge in front of the Opera House. The lamps are all arranged two in series across the mains. The current is supplied from the recently acquired station in the Rue du Faubourg-Montmartre. This station when complete will have a capacity equal to 13,000

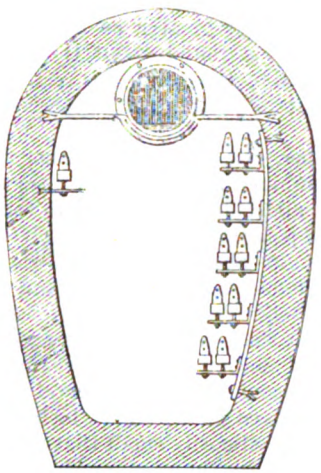

Fig. 2.—Cross-section.

16 candle-power lamps. The distribution is on the three-wire system, but in lieu of feeders the arrangement shown in Fig. 1 has been adopted. It will be seen by the diagram that the cross-section of the mains diminishes on one side of the lamps and increases on the other in such a way as to keep the total

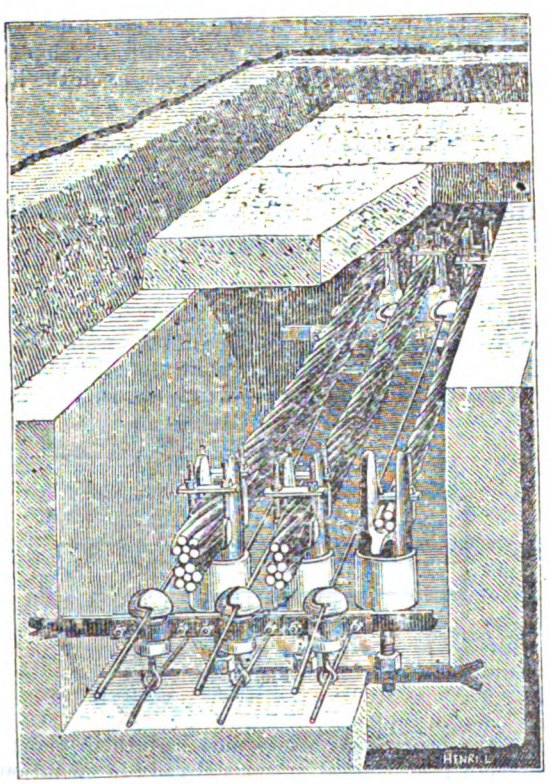

Fig. 3.—Perspective View of Condu under the Pavement.

cross-section always the same. The cables, which are of silicium bronze, are taken across the roadway in subways (Fig. 2) and along underneath the kerb in conduits (Fig. 3). In the subways the cables are run on insulators supported on cast-iron brackets fixed to the side of the subway. The conduits are of concrete, covered in by slabs of the same material, the top being about 15 centimetres beneath the asphalt. The cables are run through iron clips fixed to porcelain insulators, which are secured to transverse iron bars laid in the bed of the conduit. These supports occur at every two metres. Of the small wires shown in Fig. 3, some are used in connection with the tension indicators and some to carry the current actuating the clockwork of the subscribers' meters, while others are used for purposes of telephonic communication. The subways are connected to the conduits as shown in Fig. 4. The conduits are 37 × 55 centimetres, and the subways are in most cases 1·5 metres high and ·75 metres in breadth. At present there are five circuits running from the station in the Rue du Faubourg-Montmartre, two of which run along the Boulevards to supply the public lamps.

The Société pour la Transmission de la Force have 27 10-ampere lamps running from the Place de la Republique to the Porte St. Denis, these lamps are mounted and arranged two in series across the mains, similarly to those of the Compagnie Edison. The Compagnie Française have put up 37 Thomson-Houston arc lamps—8 on the Place de l'Opera, 10 along the Boulevard des Capucines, 5 on the Place de la Madeleine, and 14 in the Rue Royale. The mains are all run underground in iron pipes, ·2 metres in diameter, the cables being drawn in by means of openings placed 50 metres apart.

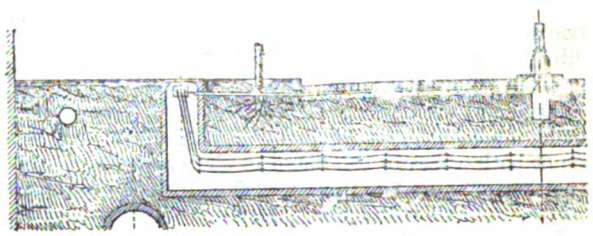

Fig. 4.—Subway under the Boulevard des Capucines.

The electric lighting of the Boulevards affords the public an excellent opportunity of seeing several systems at work side by side, and it is hoped that when the present contract terminates, which it does on the 1st November, the authorities will definitely adopt the most satisfactory of the three systems.

PROBLEMS IN ELECTRIC TRACTION.*

BY DR. LOUIS BELL.

(Concluded from page 227.)

The next experiments were to determine the losses on the line. These were found from observations of the fall of potential between power station and cars, taken both on regular and special trips. The efficiency of the line is a constantly-varying quantity, changing, of course, with the position and ohmic resistance of the motors. A general average along the line showed an efficiency of 90—95 per cent.

Attention was next turned to the speed and efficiency of the motors. The observations were confined to a single car, No. 106, which was a good average car in its general performance. As a preliminary the resistance of the motors and connections was measured with a switch in each successive step. These resistances measured cold were :—

Step.	R.	Step.	R.
1	10·76	5	2·83
2	6·98	6	2·83
3	6·98	7	2·17
4	5·44		

The resistance of an armature cold was 1·2 ohms, measured from brush to brush.

Two spaces each of $\frac{1}{10}$ mile were then measured off, one on a level, the other on a grade of 6·58 per cent. average. Experimental runs were then made with car No. 106, carrying 19 persons and instruments. The total weight of car and contents was 8,200lb. The runs were made in each case with a flying start, each step of the switch being separately tested.

* From the *Electrical World* of New York.

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The results of an experiment on the level were as follows :—

Step.	Miles per hour.	Volts.	Amperes.	E.H.P.
1	7·5	404	9·5	5·15
2	9·3	416	10·4	5·79
4	9·1	393	10·7	5·64
5	10·9	434	16·1	9·35
7	12·4	433	15·4	8·93

The somewhat anomalous result in step 4 is due to the very considerable drop in voltage.

From these experiments the efficiency of the motors may be deduced, and since the motors are geared down very nearly twelve times, the armature speed can also be obtained. In computing the electrical efficiency of the motors, allowance must, of course, be made for increase of ohmic resistance due to heating, for self-induction, hysteresis, &c. Following Mr. Sprague's own figures, I have allowed 10 per cent. increase in resistance by heating. It is my firm conviction that this, under favourable conditions, will more than cover the above losses. Nevertheless the loss due to hysteresis must be quite considerable. Computing this by Hopkinson's method for an approximate size of core, and an armature speed of 1,200 revolutions per minute, it appears that the energy spent in hysteresis may amount to somewhere about 500 watts. The loss of energy due to sparking may also rise frequently to a quite perceptible amount.

Computing then the electrical efficiencies under the various conditions we have the following results :—

Step.	Armature speed.	E.H.P.	Motor E. H. P.	$\frac{C\,e}{C\,E}$ Per cent.
1	1,000	5·15	3·72	72·3
2	1,230	5·79	4·67	80·7
4	1,200	5·64	4·74	84·2
5	1,450	9·35	8·29	88·7
7	1,650	8·93	8·18	91·5

Unfortunately a car motor does not lend itself at all readily to brake tests, the conditions of such a test being widely different from those under which the motor works. We can, however, obtain an approximation to the commercial efficiency by computing as nearly as practicable the coefficient of friction on track, and then applying this to the data obtained on a known grade to estimate the work actually done.

Assuming, then, a loss of 10 per cent. in friction of motors and gearing, in accordance with Mr. Sprague's own estimate, and using the data above, the coefficient of friction appears to be 2 per cent. ; in other words, 40 lbs. per ton. This is a high value, but, I think, justified by the condition of the track.

Substituting this constant in the formula used with the results of the grade test we can obtain a close approximation to the commercial efficiency, and a check on the above estimate of 10 per cent. friction.

The grade tests were with the same car and load. The results were as follows :—

Step.	Miles. per hour.	Volts.	Amperes.	E. H. P.
2	2·73	347	27·2	12·65
4	4·2	403	27·4	13·47
5	9·3	409	31·3	17·14
7	6·2	355	32·4	15·85

The general voltage here was rather low, produced in part by the location of the grade relative to the power station, and mainly to heavy demands for current during the test. It serves to emphasise what I have previously mentioned, the advantage of using compound-wound dynamos on tramway work.

Computing now the electrical efficiency by means of the above data—

Step.	Armature speed.	E.H.P.	Motor. E.H.P.	$\frac{C\,e}{C\,E}$
2	333	12·65	5·06	39·9 per cent.
4	545	13·47	7·98	59·3 „
5	840	17·14	13·04	76·1 „
7	830	15·85	12·50	78·9 „

Step 1 was not tried on the hill on account of endangering the field coils. Notice, for example, that in case of step 2 there is 7·59 estimated horse-power spent on internal work. No coil can stand such treatment for any length of time, and with this light it is quite easy to see why fields and armatures burn out. On a grade like this, nothing short of full power should ever be used.

Compute now the actual work done by the motors on this grade, using the above data and the friction coefficient previously found. We have then virtually the brake horse-power, and hence the commercial efficiency $\frac{B.H.P.}{E.H.P.}$.

Step.	M.E.H.P. 10 per cent.	B.H.P.	$\frac{B.H.P.}{E.H.P.}$
2	4·56	4·67	36·9 per cent.
4	7·19	7·65	56·9 „
5	11·74	11·80	67·6 „
7	11·35	11·61	73·2 „

The agreement between the second and third columns shows that the estimate of 10 per cent. for friction of motors and gears was substantially correct. A second approximation could, of course, be deduced. It appears, therefore, that the motors with their gears may reach an efficiency of over 80 per cent. on the level, or over 70 per cent. on a severe grade when used under favourable conditions. When used with the lower steps of the switch the resistance of the field coils is so high as to reduce the efficiency enormously. In other words, when the cars run slowly they do so at the expense of greatly diminished efficiency. Still, less power is used, and if the field coils are well insulated, the lowest step of the switch sufficient to give the required speed will be the most economical one. On grades, however, the fifth or seventh step should be always used to avoid excessive heating. The very high ohmic resistance of these motors is a source of continual loss, as has been pointed out in detail by Mr. Snell (*The Electrician*, Vol. XXI., p. 522), and is the cause of unnecessarily great destruction of field coils. It may be possible to so insulate the coils as to withstand the roasting to which they are too often subjected, but this is a questionable way out of the difficulty. From observations on the cars during regular trips, the average electrical efficiency in ordinary use appears to be about 75 per cent., and the commercial efficiency of motors and gearing 65 to 70 per cent. We are now in a position to obtain the approximate efficiency of the entire system $\frac{B.H.P.}{I.H.P.}$. The mean value for this line as at present worked is about 25 per cent. The chief cause of this low efficiency has been already pointed out. The figure will probably be considerably increased before long by the increasing use of stationary motors, which will raise the mean electrical output to something like the proper figure. As a system increases in size the efficiency will rise, and in a system as large as that at Richmond the total mean efficiency would appear from the data obtainable to be a little over 40 per cent. This may seem a low figure, but it should be remembered that traction work is probably the least favourable to high efficiency of any task to which an electric motor can be put. Most of the losses incurred are unavoidable ; engines will not run without friction, dynamos are not of ideal efficiency, line wire will have resistance, an electrical current will generate heat in the motors and gears will grind and wear. Losses like these cannot be avoided or reduced below certain limits. These limits are not easy to set, but one can safely say that a total mean efficiency, $\frac{B.H.P.}{I.H.P.}$, of anything over 50 per cent. would be a very remarkable performance for a traction system in actual use. I do not think that 60 per cent. is likely to be reached without very radical improvements. This applies of course to the direct supply systems.

The storage battery requires a separate investigation. In that case the power stations can be worked to rather greater advantage than with direct supply, since the load can be made much more regular. There is no loss by the wire but there is a very serious loss in the accumulators themselves. The laboratory efficiencies of storage batteries rise to a most tempting amount, 80 per cent. and over, but the irregular discharge rate necessary in operating a tramway is even more disastrous to the efficiency of a storage battery than to the efficiency of an engine. With any accumulator now made, a mean efficiency of over 65 per cent. is doubtful under the conditions which exist in tramway work. There is great need of careful tests under something like working conditions, but so far as I am aware none have been published, at least none of any scientific definiteness. I may here remark, that, with very few exceptions, the reports published on electrical traction work are models of how to avoid giving definite information. Perhaps the most serious charge against the accumulator is its very great weight. It appears to require about thirty-five hundred pounds of battery to operate a car successfully, and this amount must be carried as well as

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the passengers. Of the total electrical output then something like 25 per cent. is employed in dragging around this dead weight. But this is not all. Sit down with a list of storage batteries and compute the weight required to furnish the car, say, 10 estimated horse-power. The fact at once appears that if we undertake to supply from storage batteries the same amount of power we supply from a line, we shall need something like twice the above weight of storage battery. In short, the weight of battery is reduced by reducing the supply of power. Nevertheless, the storage system is deserving of consideration. Each car is a unit, there are no conduits or overhead wires, there is lessened danger of breakdowns, and independence generally. If the storage battery comes to be of reasonable durability and weight, it will furnish an ideal solution of the tramway problem, particularly for city work where overhead wires are a nuisance and conduits are troublesome. Given a mean efficiency of 60 to 70 per cent. for the accumulators, it is easy to form a pretty clear idea of the total mean efficiency of the storage system. The power station will be somewhat more efficient than with direct supply, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ being perhaps 80 per cent.; the batteries will be of, say, 65 per cent. efficiency, and finally the motors will be about as before, giving a total efficiency of a little less than 40 per cent. In practice this is diminished by the fact that for the same service the storage system car would require from a fourth to a third more power on account of its constant load of battery. So far as efficiency is concerned, there seems to be little prospect of the storage system equalling direct supply, since the loss on the line is so small compared with that in the battery.

Probably the most effective rival of electricity is the cable traction system, and it is well to look into its efficiency a little. Facts are not particularly easy to get at. Some of the theoretical discussions of transmission by wire rope give a preposterously high efficiency. A valuable Paper, however, in the Journal of the Association of Engineering Societies, September, 1888, gives some interesting and authentic figures as to efficiency, details of construction and cost. The St. Louis and Western cable road, having a cable in one piece, 34,600 feet long, required 185 horse power to drive the empty cable at the rate of eight miles per hour. Regular capacity of the road 40 cars (20 trains of grip and car). Under ordinary conditions of traffic 180 to 190 horse-power additional was required to operate these cars, 9—9·5 horse-power per train. Curves are numerous on the road. The Fifth-street road, Kansas City, operates 40,000 feet of cable. The conditions of working are better than at St. Louis, there being few curves. Twenty trains are operated, taking under usual conditions 280 indicated horse-power, 120 of which is required to drive the cables at the rate of eight miles per hour, leaving 8 horse-power per train as the power required. In these roads, then, 50 to 60 per cent. of the indicated horse-power seems to be applied to doing useful work.

It is instructive to compare this performance with that of the Richmond electric road, which operates single and double track, covering 8·8 miles of streets, and 40 cars aggregating almost exactly the same weight and seating capacity as the above 20 trains. The mean electrical output at the power station is per car 4·5 estimated horse-power. Making due allowance for loss in the power-station, it appears that the total power required to operate the system is about the same as in the Kansas City cable line, and distinctly less than in the St. Louis cable. The curves and grades in Richmond are more severe than in the Kansas City line.

We may conclude then that in the case of good-sized systems the power required to operate is nearly the same with cables and electricity; the former having the advantage on short and easy lines, the latter on long and difficult ones. On smaller systems electricity has a decided advantage, since the loss of power in the motors depends on their number, while the loss in dragging a cable is constant.

But there is another side to this comparison, the economic one. A cable road costs $50,000 to $75,000 per mile, owing to the large and complicated sub-structure. This does not include power stations or rolling stock. This cost is four or five times greater than for an electric overhead road, even under unfavourable conditions, and something like twice as great as for an electrical conduit system. This comparison supposes the electric road to be laid and wired in the most efficient and permanent way. Under ordinary circumstances the difference in first cost would be even greater. The difference in running expense is not so easy to estimate. Not far from the same amount of power is required, though it is probably procured at rather less expense of coal in the cable system. The number of *employés* cannot be widely different, the difference being of little moment. The cable conduit, however, requires decidedly more care than the electric line, supposing the latter to have been properly put up in the first place.

As to repairs, on an electric system using overhead wires, the line if properly put up and occasionally aligned should give very little trouble. The trolley of whatever description is subject to constant wear and must frequently be renewed or repaired, and the brushes rapidly wear out. On some lines the wear of brushes amounts to almost a set per week per car. There is great chance for improvement here. The field coils now and then burn out, in some cases frequently, and occasionally an armature is damaged. On a cable line the cable itself is a considerable item of expense. Its life may be from six to eighteen months, though occasionally only a few weeks; and the expense of renewal is considerable. The grips are subject to continual wear, the dies that form the jaws generally lasting only a week or ten days. The running gear along the line requires constant watchfulness and attention, and the minor repairs on this must be considerable. As regards the comparison of actual operating expenses, it is almost impossible to get definite information. Both cables and electricity are distinctly cheaper than horses. Reports from the Chicago cable roads indicate expenses about 50 per cent. of the cost of operating by horses. From this the figure may rise to 75 per cent. Reports of anything like a definite kind from electric roads are scarce. Such scattered figures as can be collected tend to show that the operating expenses are about the same as for cables on systems of the same size. Details of operation vary so much from place to place that it would at present be unjustifiable to say more than this. The detailed reports from electric roads have for the most part been from very small ones. A recent one from the Devonport, Ia., road shows expenses 97 per cent. of those with horses the previous year, and net profit three times as great. This road operates only four regular cars. One or two small English roads report something of the same kind, slightly diminished expenditures and greatly increased receipts.

In closing it seems worth while to say a word about the use of electricity for ordinary railroad work. In elevated roads there can be little question about the matter; the smoke and dust of the locomotive are quite enough to condemn it, and as the consumption of coal is over 6lb. per horse-power hour, an electric system can push it hard in the matter of economy. In ordinary cases, however, there is no call for sacrificing economy for the sake of the characteristic advantages of an electric system. It is quite possible for a locomotive to give the horse-power hour on 4lbs. of coal, a figure which can probably be reduced. This leaves no very large margin for the double transformation of an electric system. In fact, so long as we have to depend on the steam-engine and dynamo for our supply of electricity, competition with the direct use of steam in locomotives will be hopeless. Even water-power will not be of much avail, and the longer the line to be operated the less chance of success. If we could get electricity directly from heat in any economical way the problem of power would be solved.

Finally, with regard to electric traction systems, most lines of road are not laid and wired with sufficient care, and most of the minor difficulties in operating come from this fact. A line with track hastily and imperfectly laid, with wiring carelessly put up on rickety poles, and imperfectly aligned, will surely encounter plenty of small but exasperating difficulties and bills for repairs that will be anything but pleasant. A vigilant system of car and line inspection will avoid most of the little accidents that interrupt traffic, and will more than pay for itself in lessened repairs. With a carefully-constructed line and a properly-designed power plant, electric traction becomes thoroughly reliable and remarkably economical. Without these it may be very uncertain in its operation, and while it will nearly always pay, the size of the dividends will not be pleasant to contemplate. If much power is to be used for stationary motors, it is better and in the long run cheaper to divide the plant than to rely entirely upon a single engine.

I cannot close this Paper without expressing my obligation to Mr. Hawter, superintendent of the road, who has facilitated this investigation in every way possible, and to Messrs. F. W. Brady and W. J. Lutz, post-graduate students in this university, for most efficient aid throughout the tests.

"THE SPECIFIC RESISTANCE AND OTHER PROPERTIES OF SULPHUR."*

BY JAMES MONCKMAN, D.SC.

Resistance.

It is well known that sulphur in a solid state insulates electricity of very high potential, and conducts heat badly; also that it undergoes a curious series of changes when heated—melting at about 120deg. C., becoming thicker at 200deg. to 250deg., more liquid at 250deg. to 300deg., and boiling under atmospheric pressure at 440deg. During the past three terms I have been engaged in the Cavendish Laboratory in trying to determine whether these changes

* The above article contains the substance of two recent communications to the Royal Society, but the author has kindly rearranged the material for this journal, so as to obviate the necessity of repetition.—Ed. *E.*

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are accompanied by corresponding ones in the electrical resistance and other properties of the element.

I expected that the changes would be within the limits of an insulating body, hence my first experiment was designed to test the insulating power for frictional electricity.

Two platinum wires were placed in a beaker of melted sulphur at a distance of about 1 centimetre apart, one being connected to an electroscope, the other going to earth. When the sulphur became solid the leaves of the electroscope remained open on charging for a considerable time, but fell at once if any portion of the sulphur between the wires was liquid. To avoid all discharging by the flame used in melting the sulphur, the platinum wires were fixed to an ebonite rod at the proper distance apart. After melting the sulphur the flame was removed to a distance and the wires placed in the liquid. The discharge was complete and, apparently, as sudden as when contact was made with a wire.

The same experiment was tried with paraffin, and the discharge found to be very slow.

Seeing then that the resistance was removed by melting the sulphur into the region of conductors, it became necessary to find some method that could be used for conductors of very high resistance.

At Mr. Glazebrook's suggestion, I tried placing the wires in melted sulphur in circuit with a high-resistance reflecting galvanometer and a set of accumulators giving a total electromotive force of 60 volts. With platinum wires in the sulphur no reliable results could be obtained, as the current quickly fell away.

Having some graphite rods which had been procured from Hogarth and Hayes, Keswick, for some experiments on carbon, I

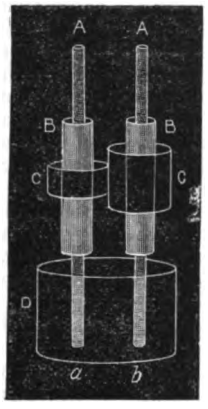

FIG. 1.

tried two of them, and obtained a perfectly constant flow of electricity, even at the boiling point. The change in the resistance between melting point and boiling point was so great that it was difficult to arrange a method that would give reliable readings. In the Cavendish Laboratory, where this work was done, we have a set of 26 accumulator cells, which when charged give a potential of about 60 volts. This is conducted to all the rooms, and is so arranged that we can use any number of cells, so that we can vary the potential from 60 volts to about 2½ volts.

When the sulphur was melted (125deg. C.) 60 volts gave a deflection with a reflecting galvanometer of 11,770 ohms resistance of only half a millimetre on the scale, while at 440deg. C. one cell gave a deflection of 60 millimetres.

By changing the number of cells, and measuring the potential by a Thomson's graded voltmeter at each change, the results given in the following tables were obtained.

The graphite rods were carefully insulated from each other by hard glass tubes, over which shorter pieces of tube of unequal length were placed, and fixed with plaster of Paris, the object being to give as much insulating surface as possible. A cell of mica was placed around the projecting part of the graphite rods to render the path of the current fairly parallel; the ends were left open to allow free access of sulphur, and to prevent vapour taking the place of the liquid when ebullition commenced.

The form of the mica cell was preserved by an outer cell of thin glass.

In Fig. 1, A, A are the graphite rods, B, B glass tubes, C, C larger ones, D mica. The exposed ends were filed flat, and fit loosely into the tube D. The dimensions are—length, 30 millimetres; width, 3⅜ millimetres; distance, 7 millimetres between the free ends *a b*.

The change of resistance was so great and fell so quickly at the higher temperatures that it gave rise to a suspicion that the increase of conductivity might arise from particles of the rods being torn off and mixed with the sulphur. To test this, the rods were placed in a second tube of boiling sulphur, so that when placed in the tube of pure sulphur they might not reduce the temperature of the liquid. After removing and allowing the adhering liquid to flow back, they were placed in the other vessel, and the current passed at once. The deflection was the same as before, and steady, neither did the rods appear to be acted upon in any way.

Hence we concluded that the change was in the sulphur itself.

RESISTANCE.

Ordinary Roll Brimstone.

Temperature.	Potential.	Deflection.	Reduced to one standard by multiplying by 60/*v*.
440°	2⅛	60	1560
300	,,	12·5	325
270	,,	2	52
250	,,	1	26
250	55	10	24
223	...	3	7
195	60	6	6
150	,,	5	5
140	,,	2	2
125	,,	0·5	0·5

Another specimen gave slightly different numbers, but of the same order.

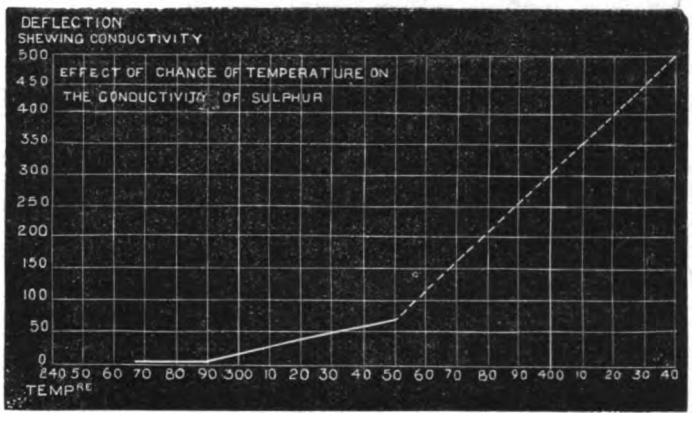

FIG. 2.

With precipitated sulphur the resistance was considerably higher.

Precipitated Sulphur.

Temperature.	Potential.	Deflection.	Reduced to one Standard by multiplying by 60/*v*.
440°	4·1	35	512
350	,,	5	73
335	...	3	44
335	8·2	7	51
290	54	5	5·5
280	,,	2·5	2·8
260	,,	0·5	0·55
125	...	Could get up a swing only.	...

The accompanying curve (Fig. 2) shows the conductivity of precipitated sulphur. At 290deg. C. there appears a sharp bend in the line. Up to that point the conductivity rises to 5·5, becoming 51 in the next 45deg., after which it rises rapidly. This bend coincides fairly with the second fluid state, and probably indicates some molecular change which appears to produce similar irregularities in its other properties.

As there was some doubt whether the impurities in ordinary sulphur and in precipitated sulphur did not produce the changes mentioned, great care was taken to prepare pure sulphur. Three methods of purification were used, and these so differed among themselves that if by any means any foreign body escaped removal they would differ in each specimen, and hence cause variations that would certainly lead to the detection of the intruder.

These methods may be indicated shortly, to give some idea of the work and avoid being tedious. First, solution in bisulphide of carbon, crystallisation from the solution, distillation in vacuo; second, distillation in sulphur chloride vapour, and then in vacuo;

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third, precipitation of sulphur from a solution of hyposulphate of soda by means of hydrochloric acid, and distillation first in air then in vacuo. This distillation was repeated many times, and only the middle portion retained.

In making the measurements very great difficulty was experienced at first in avoiding chemical action between the boiling sulphur and the electrodes, and even the glass vessel containing the liquid.

This was satisfactorily managed by using combustion tubing, protected from the direct flame, for the boiling vessel, and electrodes of thick platinum wires.

When a reading was taken the wires were immersed in the liquid and withdrawn as soon as the experiment was finished, so that the metal was exposed to the boiling liquid for a short time only, and chemical action thus avoided.

The specific resistance calculated from these three specimens is

7·7 meghoms at boiling point, or 440° C.
56·5 ,, ,, 350° C.
282·5 ,, ,, 300° C.

While precipitated sulphur gave 5·6 megohms at 440° C, at 350° C and 300° C it gave the same as pure sulphur. Roll sulphur at 440° C was 1·66 megohms.

Other experiments in the same Paper showed that the boiling point and the chemical activity changed at the same time as the electrical resistance, which suggests the idea that there is some molecular change taking place at that temperature, probably one of dissociation of more complex into simpler molecules, and that this conveys the current across an otherwise insulating body, somewhat after the manner of electrolysis in solutions.

Action of Light on Sulphur.

That the metals of the same group in the arrangement according to the periodic law have properties in common is well known. Thus chlorine, bromine, and iodine belong to the same group, and are in many respects very similar bodies. Sulphur belongs not only to the same group as selenium, but is the next element in front of it. Naturally, therefore, we expect that they will have properties

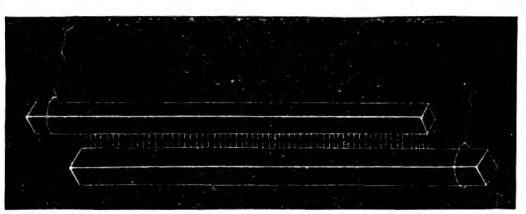

Fig. 3.

in common, and possibly the action of light in the case of the former may be shared in an inferior degree by the latter. This appears more probable from the well-known fact that a saturated solution of sulphur in bisulphide of carbon is rendered turbid by direct sunlight, part of the sulphur being changed and becoming insoluble in that liquid. A portion of the sulphur undergoes the same change when exposed to a high temperature. In order that the sulphur used in the experiment might be as sensitive as possible to light, it appeared desirable that only pure soluble sulphur should be used, and that great care should be taken not to raise the temperature in melting it so high as to produce any of the insoluble modification.

Two rectangular graphite rods (Fig. 3) were placed parallel to each other, the one projecting about an inch at one end, the other at the other end.

The edges were turned towards each other, as shown in the figure, leaving a space of one millimetre, which was filled with melted sulphur. This was levelled off with a hot iron to make the portion between the corners as thin as possible.

A quadrant electro-meter was charged, and the graphite rods, separated by sulphur, inserted between the binding screws, so that the negative quadrant was connected with the positive one through the sulphur (1·5 centimetre long, 1 millimetre thick, and 1 millimetre broad).

The electrometer was charged to the same potential in each experiment in a series and allowed to run down for a certain time. Sunlight was allowed to fall on the sulphur, but shaded from the rest of the apparatus; when not required the ordinary window-blind was drawn down.

Of course the electrometer and sulphur were protected from induction by surrounding bodies by wire screens.

The following three series of readings were taken on different days, and in one or two cases clouds interfered with the experiment, especially in No. 8, when the light was considerably shaded by cloud:—

—	Scale deflection at the beginning.	Time.	Fall in scale divisions.	State.
		minutes.		
1st series (1).....	180	30	20	Dark.
,, (2).....	,,	15	20	Light.
,, (3).....	,,	35	18	Dark.
2nd series (4)	300	15	25	Light.
,, (5)	,,	17	25	,,
,, (6)	,,	15	20	Dark.
,, (7)	,,	15	19	,,
,, (8)	,,	15	20	Light.
3rd series (9)	200	15	14	Light.
,, (10)	,,	15	17	,,
,, (11)	,,	16·5	16	,,
,, (12)	,,	15	10	Dark.
,, (13)	,,	15	10	,,

The first and second series were alternated dark and light in the same set of experiments to see that no permanent change was produced and mistaken for the effect sought. In the first the time varied and the deflections were allowed to fall the same distance; in all the others the time was the same and the fall varied.

The method of performing the experiments made it possible that the effect might be produced by the heat of the sun and not by the light. The variation in temperature observed on a delicate thermometer was about 1° C. To eliminate the effect of heat, a long series of observations was made in the dark, whilst the temperature was raised slightly by placing a Bunsen flame 4in. or 5in. away from the screen protecting the sulphur, and the heat radiated by placing an iron spiral in it, then one of copper, and lastly a fine-clay tile.

The range of temperature was 15·2° C. to 17·1° C. in the first ten experiments, in which the heated ones fell rather more slowly than those at a lower temperature. In the next seven observations the range was 14·8° C. to 18° C., the fall being exactly the same in each.

There yet remained the possibility that the light falling on the wires which held the rods caused the charge to escape more quickly into the air. When, however, the sulphur was removed, the effect produced by the light on the portions of wire exposed to its influence was too small to produce any change in the rate of fall.

Hence it appears that although selenium is the body most sensitive to the action of light, it shares its property with its neighbours, and the three elements (constituting the same group), sulphur, selenium, and tellurium, are all similarly acted upon, furnishing another example of the importance and beauty of the law which classified them together.

"THE ECONOMICS OF ELECTRIC LIGHT AND POWER STATIONS."

In connection with the interesting series of Papers by Mr. A. P. Wright under the above title, Part I. of which we have recently reprinted from our Boston (U.S.) contemporary *Modern Light and Heat*, several correspondents were not able fully to understand the load diagram, which is reproduced below from our issue of March 8th. We have, therefore, addressed a letter to the editor of our contemporary, requesting him to be good enough to ask the author for some further explanation. The following reply is printed in *Modern Light and Heat* of April 25th:—

"TO THE EDITOR OF 'MODERN LIGHT AND HEAT.'

"SIR: In reply to your favour enclosing communication from the editor of *The Electrician* of London, *in re* my recent articles in *Modern Light and Heat*, I have to request that, in addition to the explanation I give below, you will also convey to that gentleman my appreciation of the endorsement the articles referred to have received by their republication in *The Electrician*.

"In further explanation of the station output it may be stated that the curve represents the variations in indicated horse-power during the twenty-four hours of one of the shortest days in the year—Saturday—and in it are shown not only the total indicated energy used but the various amounts required for the different classes of electrical work. Referring again to the diagram, it will be observed, following the curves, that 'commencing at 12 o clock

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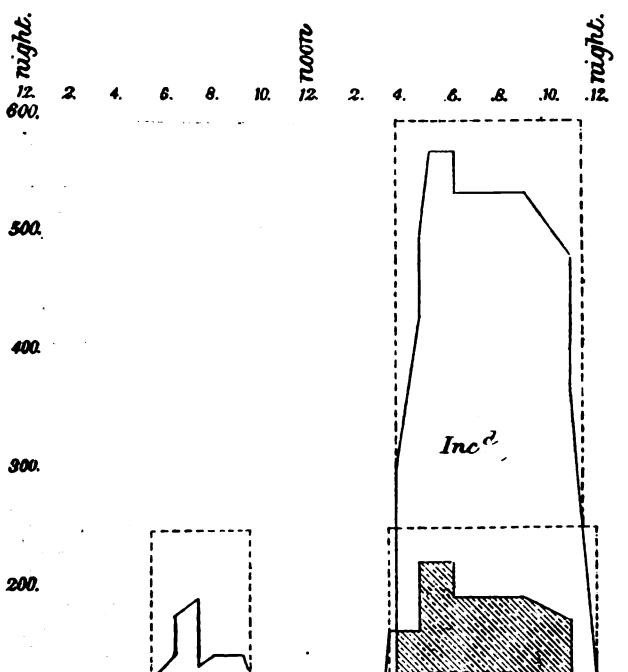
at night, the power required is uniform' for some time, about 60 horse-power for 2,000 candle-power arc lamps used for street lighting and the balance of the energy being consumed for incandescent lamps. The incandescent output naturally increases as the world begins to wake, and is indicated by the curve. The composition of the load is shown at all times by the sectional areas of the curve, that marked '2,000 candle-power' representing not only the amount of energy consumed by the street lamps but the duration of this lighting. In the same way the areas sectioned in the opposite direction and marked *motor* indicate the period and amount of power transmitted to motors. The area marked '1,200 candle-power, likewise represents the time occupied in commercial arc lighting, while the unsectioned area marked 'Inc.,' which is the complement to the others, represents the details of incandescent lighting.

"It was not intended at this period in the articles to enter into the details of the composition of the load, as it was proposed to show several of these curves for different days, such as Saturday, Sunday, and ordinary days, both winter and summer, when taking up the question of recording readings of current and power, in a section of the articles which is to follow later on, and which will deal with 'Operation and Management.'

"The object of using the curve, which is one of a set to be used later, was to indicate the economical subdivision of the power units in such a way as to keep the engines working within their economical limits, as shown by the dotted lines in the diagram. Referring



The vertical scale is the power scale, in units of 100 horse-power.

to the diagram it will be noticed that at twelve o'clock at night the dotted line indicates the use of an engine of 125 horse-power until about 4:30 a.m., when one of a capacity of 250 horse-power takes its place until about nine o'clock, when the first engine is again called into use. As the day darkens and the lights turned on require more power a 250 horse-power engine is started and the 125 horse-power stopped, and a little later a larger engine of 350 horse-power is started and coupled with the 250 horse-power. If the power curve is compared with the areas enclosed by the dotted lines it will be evident that for a short period only can the engines be working disadvantageously. The curves which will be used to illustrate these articles are all prepared from data actually obtained during the operation of a station similar to that described.

"In reply to the question as to the difference in the average lamp hours, 2,095—as compared with the supposed average on the other side of from 700 to 800 hours—it may be stated that in this case there is no assumption of lamp-hours, the figures being actually deduced from the curves for twelve months, and the apparent excess can easily be accounted for if it is remembered that in the particular case dealt with the lighting is entirely business lighting, and that a considerable amount of light is used during the day, as indicated by the diagram; and the list of customers includes a great many who use their light until eleven and twelve o'clock and all night, while there are very few house lights to reduce the average, as would be the case if general lighting were done.

"The first article is intended to be the result of a discussion as to the advisability of entering into the lighting business, and with a view to arriving at a basis upon which an engineer is to prepare plans and estimates. The articles to follow will present plans and estimates; will deal with construction, both inside and outside; with distribution and with management and operation, the various duties of the manager, his staff, and a system of records and reports, by means of which a proper analysis of the cost of production may be arrived at.—Yours truly, "ALEX. P. WRIGHT."

SOME RESULTS WITH SECONDARY BATTERIES IN TRAIN LIGHTING.*

BY ALEXANDER S. BROWN.

It is now four years since the Pennsylvania Railroad, appreciating the advantages of electric lighting for this purpose, began a series of experiments with the secondary battery for the illumination of parlour cars. I am unable to give the cost of lighting by any of the batteries referred to, as the expense appears to have been a secondary consideration compared with the necessity of securing the best system of illumination. During the summer of 1884, experiments with the Brush storage batteries were commenced at the Altoona shops of the Pennsylvania Railroad, and continued through the fall and winter of that year. These experiments were made by Dr. Dudley, and proved so successful that eight parlour cars, which were being constructed at that time, were equipped for incandescent lighting and put into regular service on the 1st of April, 1885.

The Brush cells used consisted of three plates each, two negative and one positive, the amount of surface of the positive plate being equal to that of both the negatives. These plates differed from those now used, there being no paste in their composition. The negative is designed to give the greatest possible surface from the least weight of material. The positive plate measured 8″ × 9″ × 1″ and the negative 8″ × 9″ × ½″. These batteries are rated at 70 ampere hours, but the hard usage they received soon reduced their capacity, and at the end of a year's time the positive plates were almost entirely destroyed. In fact I have taken plates out of the cells which had holes in them fully four inches in diameter, while the deposit in the bottom of the cell would be from an inch to an inch and a-half in depth. The plates also had a decided tendency both to buckle and grow, and in a number of cases it was a very difficult matter to remove the plates without injury to the cell; you will understand, of course, that I allude more particularly to the positive plate. The weak points in the Brush battery were the small number of ampere hours per pound of material—about two I believe. There was a tendency to buckle and sulphate, and the arrangement for connecting the plates was such that there was oxidation at the junction, causing the plates to break when subject to the motion of the car. This last feature was a source of endless trouble to us, and as is usually the case, was sure to happen at a time or place where it was impossible to repair the break. While using the Brush battery the cars were wired with the battery boxes, one on each side of the car, coupled together in series, each box holding three trays, and each tray containing four cells, this giving a total of 24 cells to a car, or an E.M.F. of 48 volts.

The lamps used originally were of the Brush-Swan type, with small platinum loops projecting from the base, these hooking into a socket, and held in place by a spiral spring, this socket fitting into another one, to which the connections to the wires were made. After using this style for some time an improved pattern of Brush-Swan lamp was substituted, but the great drawback to this lamp was its frailty, the breakage per day often averaging 4 per cent. of the total number of lamps in use on all the cars. These lamps required about 45 volts and 1 ampere of current, and each car contained 10 lamps, seven in the body, one in the smoking room and one in each vestibule, thus using about 10 amperes of current, and as the batteries were rated at 70 ampere hours, we should have obtained from six and one-half to seven hours' good light, but it was very seldom, after the batteries had been used for a short time, that we could get over five and one-half hours. As will readily be seen, this could hardly be called economical, for to obtain five or six hours' light we were obliged to charge from 15 to 20 hours with a Brush arc light dynamo giving a current of about 10 amperes. Then taking the weight into consideration, each time the car needed charging, the trays, six in number, and weighing 1,200lb., had to be loaded on the track, pulled over to one side of the car, and the discharged trays taken out and the freshly charged ones put in their place. The remaining three were then taken around to the other side of the car and changed in the same manner. As the cars invariably stood on a double track it was necessary to carry half the trays for some distance, over tracks, &c. Then, again, the tracks were usually full of cars, and if there was not sufficient time for them to be parted, the batteries had either to be carried under the car or over the platform. Under the present system this has been done away with to a great extent, as will be explained subsequently. During the month of December, 1886, we commenced using one battery of the 7 B type, manufactured by the Electrical Accumulator Company. This battery was a decided improvement over those pre-

* A Paper read before the American Institute of Electrical Engineers, New York, May 22, 1889.

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viously used, giving as it did nearly double the number of ampere hours for the same weight of material. After using this battery for about a year the positive plate began to give way, and new ones were substituted, the negatives, however, being retained, they not having deteriorated; in fact, we are still using the negative plates of our original 7 B battery. This battery proved to be so satisfactory that in June, 1887, we added two more of the same type and two manufactured by the Julien Electric Company. The latter batteries were similar in size and shape to the 7 B type of the Accumulator Company, but did not seem to stand the hard usage so well, as they would crack instead of buckling, and allow a large quantity of the paste to become loosened and fall out. It is proper to state, however, that these plates were made especially for us to fit the cells we were using, and were not of the regular Julien type. This, no doubt, will account in a great measure for their failure to keep up the standard of the present type of Julien batteries. After the positive plates of this battery became worthless, and not having any others to put in their place, we decided to make a kind of consolidated affair and see how Julien negative and accumulator positive plates would work together. The result was extremely satisfactory, and we have had no trouble with them whatever, excepting the occasional buckling of a positive plate.

During the fall of 1887, we began substituting the Accumulator batteries for the Brush batteries, and by the end of the year we were using them altogether, with the exception of the two Julien I have mentioned. We, however, kept 96 of our best Brush cells, to be used in case of an accident to the incandescent dynamos, which are used to supply the current for the railroad telegraph as well as for lighting the passenger station.

After the change in batteries had been made, it was thought best to change the system of wiring the cars, so that instead of its being necessary to put batteries on each side of the car, we need only put them on one side, and get the same amount of light. This was done by connecting the two boxes under the car in parallel, and substituting 23-volt Edison lamps for our 45-volt Brush-Swan lamps. After doing this we found that we were able to get as many hours light from 12 cells as we formerly did from 24. Of course this change reduced the expense of lighting the cars considerably, for where we formerly had a change of battery for each car, or 48 cells, we now needed only 24 cells per car, with a few extra ones to be used in case the 12 cells would not be able to supply sufficient light for a long trip. This system of lighting proved so successful that it was decided to substitute it for gas in the remaining seven parlour cars. The wiring of these cars was commenced at the Meadow shops, near Jersey City, last September, and has just been completed. These cars are arranged for the 23 C type of the Accumulator Company's battery, and 19 B type of the Julien battery. The battery boxes under the cars are larger than the old style and contain four trays, or 16 cells, the lamps we used taking 23 volts E.M.F. Changes were also made the first of the year in the system of charging, and the batteries are now charged from an incandescent dynamo instead of an arc, thus enabling the batteries to be charged with any amount of current desired. In connection with this description of the four years' work of the Pennsylvania Railroad, I would like to add something in regard to the electric lighting of the Chicago limited express.

In 1887, the Pullman Palace Car Company commenced using the electric light on one of three trains of the New York and Chicago limited express, and the charging of the batteries at Jersey City was given into the hands of the Pennsylvania Railroad Company. The batteries used were the 7 B type of the Electrical Accumulator Company, 30 cells to a car, and usually there are six cars in the train. These batteries would furnish enough light for one trip, and each time the train arrived at either terminus it was necessary to replace them with freshly-charged cells. This was not objectionable at Chicago, for the train arrived there in the morning, so that they could be charged during the day, but in Jersey City, where the train did not arrive until evening, the work was very difficult on account of the dynamo being in use for other purposes. After this one train had been running a short time, another one was fitted up, 19 B type of Julien battery being used. It was thought that this would give us a chance to see which was the better of the two batteries, but they both worked very well considering the treatment they received. After Mr. Bauer became connected with the Pullman Company, he did away with charging the batteries at the ends of the line, and introduced a Brotherhood engine and Eickemeyer dynamo in the baggage car of each train in order that the batteries might be charged in transit. When the train leaves Jersey City, the baggage car is on the rear, and consequently no charging is done until it leaves Philadelphia, where the train is reversed, bringing the baggage car next to the locomotive. The batteries are charged continuously until the train reaches Chicago, and the same practice is continued on the return trip. The steam for driving the Brotherhood engine is taken from the locomotive boiler, and the exhaust is used for heating the train.

So far as the Pennsylvania Railroad is concerned the electric lighting of passenger trains may be considered an assured success, and leading as it does to the abolition of kerosene lamps, and incidentally encouraging the adoption of steam heating, the safety and comfort of the passenger is certainly increased.

BOOKS, &c., RECEIVED.

"Electro-Metallurgy." By ALEXANDER WATT. Ninth Edition, Enlarged and Revised. (London: Crosby, Lockwood and Son.)

"Fortschritte der Elektrotechnik." Vol. III. (Berlin: Julius Springer.)

"Practical Electric Bell Fitting." By F. C. ALLSOP. (London: E. and F. N. Spon.)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *June* 29, 1889.

A most important piece of legislation has just been approved by the Governor of the State affecting particularly the street railways of this city. For a long time past some of the railroad companies have been seeking to obtain powers by which they might run their cars with other than animal power, but hitherto they have been unable to effect their purpose. During the last meeting of the New York Legislature a Bill was introduced and passed allowing the companies to employ other than animal power, and Governor Hill has now signed the Bill. This is an important measure, from the fact that some of the companies which it is likely to affect have a very large equipment of horses, and are among the largest street railway companies in the world. Thus, for example, the Seventh Avenue Road is operating 227 cars with 1,900 horses; the Central Park Company has 165 cars, with 1,200 horses; the Dry Dock Company has 185 cars and 1,017 horses; the Eighth Avenue has 112 cars and 1,155 horses; the New York and Harlem, or Fourth Avenue Company, belonging to theVanderbilts, has 162 cars and 1,250 horses; the Sixth Avenue Road has 117 cars and 1,100 horses; the Second Avenue Road has 316 cars and 1,780 horses; the Third Avenue Road has 391 cars and 1,800 horses, and the Twenty-third-street Road has 93 cars and 850 horses. I have enumerated these figures which by no means include all the roads in the city, for the purpose of showing how large is the street railway plant employed in New York, and what an immense number of horses is required to operate them. These horses, of course, are scattered all over the city in huge stables, occupying ground of almost fabulous value, and yet under such conditions as cannot be considered healthful either for the horses or for the people in the neighbourhood. Moreover, during the summer time, the trouble with the horses under the intense heat, becomes very serious, and on holidays and Sundays, just when roads should do their heaviest work, they are crippled because of the utter inadequacy in the inverse ratio of the animal power required to move the cars. The new Bill having been passed, we may look for some important developments. The Fourth Avenue Road will probably go in even more heavily than it has done for electricity, with the Julien storage batteries, but at first on other roads the probability is that the cable will be pretty extensively introduced. The Third Avenue Railroad Company have been operating a cable road on the outskirts of the city with a good deal of success. It has proved an immense convenience to the road and passengers, and hence nothing is more likely than that the Third Avenue Company will at once extend the cable service over its whole system, and operate by that means from Harlem Bridge to the City Hall, beneath the elevated tracks of Mr. Jay Gould's Manhattan Company. There is one point of difficulty which presents itself, however, and that is the fact that the city is just preparing to spend £600,000 on new paving, and it certainly will not do to have this paving put down only to be pulled up again a few months after by the cable contractors. Probably some sort of compromise or working arrangement will be arrived at, but in the meantime it is hoped by electricians that the occasion will before long give them an opportunity to do part of the work which now promises. It may be noted, in passing, that the Bentley-Knight people have not so far felt called upon to put their conduit system in operation down town on Fulton-street, although the tracks and conduits have been ready for some months past. Perhaps now that the new law has removed all doubt as to the legality of using electricity, the company owning the road will go ahead and put its whole plant in operation. From Boston the news comes that the West End Company has been disposing of large blocks of its land in the suburbs to raise money for the equipment of its vast electric system, using the overhead trolley and it is said that in a few days contracts will be given out for as many as a thousand electric cars. As you are aware the West End Company are already operating Sprague, Bentley-Knight and Thomson-Houston cars with success on the out-

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lying portions of their system, but what they now have to do is to replace by electricity their present equipment of 775 box cars, 806 open or summer cars and 7,684 horses. Surely it will be a good day for the horses when they are thus released from the slavery of street-car service and their places taken by the hardy and never weary electric motor.

One of the cities which has recently been considering it good policy to put in an electric light plant of its own is Bangor, Maine, which last week had the pleasure of seeing a fine new Brush plant go into operation at the city waterworks. The pretty city of Bangor is supplied with water from the Penobscot River, the works being situated about one and a-half mile from the centre of the city. Until about a year ago water was forced into the mains by a 3,000,000 gallon pump operated by three powerful turbines, but it was found necessary to increase the service, and hence a new system of turbines and pumps was put in, leaving idle the old outfit. It then occurred to some of the city authorities that the disused water plant might be used to run an electric light plant owned by the city, which was then paying about $9,000 a year for its street illumination by arcs, gas jets, and naphtha lamps. The local Thomson-Houston Company then offered to do the whole lighting at the rate of about $8,400 a-year, but it was determined to leave them out in the cold and to put in this new plant, the cost of operating which is put at about $5,000 a-year. It is interesting to note that poles are used, the city having put up no fewer than about 800 cedar poles from 30ft. to 35ft. high, and over 40 miles of overhead wire. As the example of Bangor will probably be followed by other places in New England, it can be understood that this movement is watched with some little apprehension by local companies that have invested large sums of money in the plant under the reasonable assumption that such of the public lighting as was to be done by electricity will be given to them. It will be readily understood, too, that were the city thus goes into the business it very often does its citizens more harm than good. Where the plant has both the city and the commercial lighting there is a chance of doing a good business or operating at a profit; but when the public lighting is thus taken away, what remains is hardly worth looking at. This difficulty has already been experienced in one or two New England towns where the city authorities have attempted, but unsuccessfully, to secure the right to engage in a general and commercial electrical business. There are, of course, two objections to this. One is that the city thus drives out of business altogether some of its most enterprising citizens who have started their plant in the reasonable belief that they would have public support and not municipal competition, and the other is that for a city to undertake to give all the electrical service that is required of it would necessitate the raising and expenditure of a far larger sum of money than it is wise for any community to guarantee the interest on.

The propriety of inflicting sentence of death by electricity in this State was discussed this week in connection with the appeal on behalf of the murderer Kemmler. As I stated in my last, Mr. Bourke Cockran, one of the most prominent of the younger advocates at the New York Bar, undertook to fight the case for Kemmler, distinctly disavowing, however, any connection with the Westinghouse people, whose apparatus it has been proposed to employ, much against their will, for administering the fatal shock. Mr. Cockran appeared before the Court at Auburn on June 25th, and made a very forcible statement as to the legal merits of the case. He pointed out that the constitution of the State forbids the infliction of cruel or unusual punishment, and he held that no State Legislature had the right to inflict a punishment which was not within the contemplation and meaning of the constitution, whether national or State. He found an interesting precedent in the case of Feltom, who killed the Duke of Buckingham, and who asked that his hand might be cut off as a punishment, when it was held by the judges that the right to inflict torture had no place in English jurisprudence. Mr. Cockran insisted that the only knowledge which the Commission had obtained as to the effect of the electrical current was gained by experiments with dogs and other four-footed beasts, while no facts had been elicited which would go to show that the condemned man may not suffer the most exquisite torture. He wished to know whether the Court would tolerate the burning of a criminal at the stake in the city market-place, and whether it would allow a man to be hanged and then cut down and disembowelled before life was extinct. Yet while the Court would certainly not allow such practices as that, it would be as much at fault if it allowed the uncertain electrical method to be applied. The State should not experiment with human life. Mr. Cockran closed by offering to prove his allegation that the punishment was unusual and cruel, and could not be lawfully inflicted, and although he was followed by the Attorney-General of the State, who argued that the law was constitutional, and that the Legislature had the power to inflict death by electricity, the Court decided that evidence was necessary to enable it to decide the question; and the case was further adjourned until July 30, evidence to be taken in the meantime before a referee. Thus you will see, as I ventured to predict, there is not a little delay in carrying out capital punishment by the new means, and in many quarters the opinion begins to prevail that at the next meeting of the Legislature the law will be repealed, and that ordinary rope will be declared good enough.

From time to time one hears interesting stories as to the ageing and general improvement of wines and liquors by electricity. You will doubtless remember the experiments made not long ago by Mr. Edison, who placed an incandescent lamp in a barrel of whisky, with the result of greatly improving the quality of the spirit. I believe that this experiment was carried out on various occasions, but I do not think that the process has been regularly developed anywhere in a practical way. News now comes from California, however, of some work that has been done in San Francisco by a Mr. F. M. Speed, who, it appears, is ageing Californian wines by winding wire around the cask in which the wine is contained, and passing heavy currents through the coils. The time of treatment is 18 to 25 days, after which period, it is said, the wine has lost its harshness and shows many of the qualities of wine that is properly aged. It is also said to be unusually agreeable to persons of weak digestions, while it has the charming characteristic that it no longer causes headache. There is no doubt that should Mr. Speed carry out his amiable intentions and avert by means of his wire-wound barrels the consequences that are apt to follow the midnight revel, he will be regarded as a benefactor by a large portion of the human race. Henceforth, then, the enthusiastic toper can look upon the wine when it is red with impunity, provided it has been "electroplated," as the Californian papers phrase it.

Some very interesting work is being planned by the Committee on State and Municipal Legislation, which was appointed at its recent Chicago meeting by the National Electric Light Association. With forty odd legislatures almost incessantly at work it can be readily understood that the various electrical companies are likely to be greatly harassed and vexed by laws passed ostensibly to promote the public welfare. In more than one State the electric light interest has been attacked and seriously imperilled, not only by measures introduced into the legislature but by ordinances introduced in the municipal councils, and it is felt that the time has arrived when co-operative action in the way of watching such measures and fighting them is imperatively needed and can do great good. Hence it is that the Committee in question has been appointed by the National Electric Light Association, and is already getting ready for grappling with the problems of legislation that arise from time to time. The chairman of this Committee is Mr. A. R. Foote, whose recent book on the "Economic Value of Light and Power" is probably familiar to some of your readers. Just at this time, as I showed at the beginning of my letter, considerable interest is taken in the question of the purchase of electric lights by the municipalities, and it is seen that in a great many places where companies have already been established under State and Municipal sanction it will amount to little short of robbery if, by the establishment of city plants with the proceeds of taxation, to which they have themselves contributed, they are deprived of the business which they were the first to develop, and which they have built up by hard work.

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CORRESPONDENCE.

PHOTOGRAPHING LIGHTNING WITH A MOVING CAMERA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been experimenting with a Wimshurst machine giving sparks one inch and a-quarter long. I have photographed several of these sparks and enclose copies of two. The one which is of a ribbon-like form was taken while the camera was being shaken up and down with the hands, and the other was taken with a fixed camera; and if there is time to move a camera during the time an inch and a-quarter spark is visible, and produce a ribbon-like form of flash, it proves that ribbon lightning would be the result of moving the camera during the time a flash of lightning was visible. To me it seems almost impossible for any one to hold a camera in his hands to photograph the lightning without jerking it when the discharge takes place.—Yours truly, A. W. CRAMP, jun.

225, Bethnal Green-road, London.
July 9th, 1889.

[The photographs enclosed show in one case a very sharply defined flash, and in the other a thick ribbon-like discharge.—ED *E.*]

THE ELECTRIC LIGHTING OF MARIENBAD.

A correspondent writes as follows:—"The above central station, which has been erected for the town and authorities of Marienbad by Messrs. Ganz and Co., was opened on the 30th of last month. It was originally intended to supply 35 arcs for public use and about 1,200 glow lamps for private customers. The applications for the latter were, however, so much in excess of what was expected that the plant was much enlarged. The present output is 1,800 glow and 48 arc lamps, in addition to those used for public lighting, as above mentioned. The station is at a distance of over a mile from Marienbad, and covers about 700 square yards. There are four sets of machines, one being always in reserve. Each set consists of a 50,000-watt Zipernowski alternator, driven direct by an 80 horse-power Westinghouse engine at 500 revolutions, and a 3,000-watt exciter driven from the same source by a belt. Each set stands on its own separate foundation. The leads, both primary and secondary, are carried on poles about 30 metres apart. The transformers have cast-iron bases and sheet-iron covers; those for public lighting are on poles, those for private use are some on poles and some in the houses. After midnight the public arc-lamps are turned out and glow-lamps substituted.

LEGAL INTELLIGENCE.

United Telephone Company v. Liversedge and Co.

The action of the United Telephone Company *v.* Liversedge and Co. was heard on Saturday last, before Mr. Justice North, in the Chancery Division of the High Court of Justice.

Mr. WICKLEM said the action came on upon motion for judgment in default of defence. The action was brought for an injunction to restrain the infringement of the Edison transmitter and the Bell receiver, and the claim asked that the infringing instruments might be delivered up to the plaintiffs. With the statement of claim particulars of breaches were delivered, and he asked for an order in the same terms in which the Courts had previously made them, with costs up to judgment, the costs of the inquiry as to damages being reserved.

His LORDSHIP made the order as asked.

A similar order was made by Mr. JUSTICE CHITTY in an action of the United Telephone Company *v.* Brierley, which was heard as a short cause, the defendant not appearing.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

June 13, 1889.

9,743. C. RICHARDSON. Manchester. Improvements in field magnets of dynamos and electromotors.

9,745. W. S. BOULT. Birkenhead. Improvements in or relating to dynamo-electric machines.

June 15, 1889.

9,828. W. J. S. BARBER-STARKEY. Manchester. Improvements in secondary voltaic batteries.

June 17, 1889.

9,885. G. SCARLETT. Liverpool. Improvements in or relating to electrical alarm clocks and indicators.

9,917. F. B. NICHOLSON. London. Improvements in switches used for electrical purposes.

9,945. L. HANSON. Halifax. Improvements in arc lamps.

9,977. W. P. THOMPSON. Liverpool. Improvements in electrical reciprocating tools (H. N. Marvin, United States).

June 18, 1889.

9,988. J. S. RAWORTH. London. Improvements in electricity meters.

9,994. E. MAIGROT and J. SABATES. London. Improvements in apparatus for the manufacture of sugar by electricity.

9,999. E. T. TRUMAN. London. Improvements in the manufacture of insulated electrical conductors and cables.

June 20, 1889.

10,082. G. BINSWANGER. Improvements relating to electric switches, fuse-blocks, ceiling-plates, and the like.

10,102. H. J. ALLISON. London. Improvements in subterranean conduits for electric wires, &c., which may also be employed for the purposes of pneumatic transmission (R. Macdonald, United States).

SPECIFICATIONS PUBLISHED.

1888.

8,170A. ALLISON (The Baxter Electric Manufacturing and Motor Company). Electric shunting device. (Price 8d.)

9,171. LANGDON. Electric lighting. (Price 11d.)

9,747. WINNALL. Electric bells. (Price 8d.)

10,194. COCKBURN. Electrical switches. (Price 8d.)

10,956. SMITH (Nachfolger). Electrical lighting apparatus. (Price 8d.)

10,941. TIMMIS. Lighting trains by electricity. (Price 8d.)

11,749. SELLON. Electric lamps. (Price 8d.)

12,858. ZIPERNOWSKI and DERI. Distributing electric energy. (Price 8d.)

13,934. KENDALL and COOPER. Electric circuits. (Price 8d.)

1889.

5,881. BALET. Regulating electric currents. (Price 1s. 8d.)

4,960. LAWRENCE. Administering electricity. (Price 8d.)

5,912. VAN DEPOELE. Suspending electric conductors. (Price 8d.)

6,064. LAKE (Thomson). Electro-magnets, &c. (Price 8d.)

6,065. LAKE (Thomson). Electric motors. (Price 8d.)

6,547. CURRIE. Circuit controllers for electric currents. (Price 8d.)

6,622. HOWARD and others. Electrical switches, &c. (Price 4d.)

6,804. LAKE (Straton). Telephone transmitters. (Price 8d.)

6,856. BOULT (Heydler). Microphones. (Price 6d.)

6,865. HEYL. Secondary batteries. (Price 4d.)

7,002. HICKS. Secondary batteries. (Price 6d.)

7,356. MALTBY-NEWTON. Galvanic batteries. (Price 6d.)

7,619. BARBER-STARKEY. Electric batteries. (Price 6d.)

7,645. COOK. Electrical conductors. (Price 8d.)

7,647. WHEELER. Electric motors, &c. (Price 8d.)

Reprints (with alterations).

14,542. SANDWELL. Electric motors. (Price 11d.)

Second edition, 1885.

3,379. THOMPSON (ZIPERNOWSKY and another). Distributing electricity. (Price 1s. 1d.)

COMPANIES' MEETINGS & REPORTS.

Crompton and Co. (Limited).

The Right Hon. Viscount Torrington presided yesterday at the City Terminus Hotel, Cannon-street, over the first annual general meeting of the members of Crompton and Co. (Limited).

The SECRETARY (Mr. Francis R. Reeves) read the notice convening the meeting.

The following is an abstract from the report of the directors:—The net profits admit of the payment of dividends both on the Preferred and Ordinary Shares. After payment of the interim dividend in January last, and providing for vendors' interest and other payments shown in the accounts, there remains a surplus of £5,433. 2s. 7d., which the directors propose to dispose of as follows:—(1) To carry to a suspense account a sum of £1,500 as a provision for doubtful debts and contingencies. (2) To place a sum of £568 to a reserve fund for equalising future dividends. (3) To declare a dividend of 7 per cent. per annum on the Preference Shares. (4) To pay the managing directors their fees of £1,000, according to the Articles of Association. (5) To declare a dividend of 5 per cent. per annum on the Ordinary Shares.

The sum of £4,594. 11s. 6d. has been expended upon enlargement of the works at Chelmsford, and for additions to plant and fixtures. The works are thus rendered much more efficient for economical manufacture, and when the new offices which are in course of construction are completed much time and expense will be saved in the management of the business.

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Contracts for lighting have been agreed with the Corporations of Folkestone and Chelmsford, and orders for central stations for several provincial towns are practically arranged for. The business of the company with the Australian Colonies is rapidly increasing, so much so that the company's agents, Messrs. Harrison and Whiffen, have requested that additional capital may be provided by means of a separate company, to which they would themselves largely subscribe. An Australian company has accordingly been registered, and a circular on the subject will shortly be forwarded to the members of this company. The Directors' report was taken as read.

The CHAIRMAN: I have now to move—

"That the report of the Directors, and the audited statement of accounts for the year ended March 31 last, be and are hereby approved and adopted."

Gent'emen, the Directors feel that they may congratulate the shareholders upon the satisfactory position of the Company, as shown by the statement of accounts which has been laid before you. The Company has been barely a year in existence, and only eight months of this time are comprised in the report, yet the net profits are above the average of those of preceding years. It will be seen from a perusal of the accounts that the directors have, while maintaining the buildings and plant in complete repair, written off a sum of £1,554 as depreciation. They further propose to carry forward £1,500 to provide for any possible contingency that may arise and for doubtful debts, though there can hardly be expected to be many of the latter, as the accounts are not a year old. They then propose to place a sum of £568 to reserve fund for the purpose of equalising future dividends. It may be said that this is not a large sum; still, it is a beginning, and considering that the Company has only been working eight months, it may be looked upon as a very fair start. In making these deductions from the profits before declaring a dividend, the Directors feel that they are acting prudently as men of business, and that they are doing their best to make the position of the Company a strong one. It is only fair to add that the holders of the Ordinary Shares cheerfully acquiesced in these proposals, though in doing so they are depriving themselves of so much more profit. I mean, of course, Messrs. Crompton and Albright. After setting aside these sums the Board proposed to pay the full dividend of 7 per cent. on the Preferred Shares to the 31st March; then to pay the Managing Directors their fees, which they are not entitled to draw until the dividend is paid on the Preferred Shares, although the Company has the full benefit of their constant attention; and finally it is proposed to pay a dividend of 5 per cent. on the Ordinary Shares. So much with respect to the past. The future looks very promising. The works are busy, and orders are constantly arriving. There is just now a great revival of the electrical industry, consequent on the passing of the Electric Lighting Act Amendment Bill. Many new companies have been formed, and the Board of Trade, after holding an inquiry into the applications for Provisional Orders and Licences which have been made under the Acts, has officially sanctioned many of the projects. Manufacturers are consequently very busy, this Company, in common with many others, having a large increase of orders. The Directors believe that a very prosperous future is before them, and every effort is being made, by careful attention to details, to ensure that the work shall be executed in such a manner as to keep the name of the Company in the front rank of reliable makers. A circular and prospectus of the Australian Company referred to in the report have been sent to the members, and these papers fully explain both the object of the new company and the reason for its formation. The Directors believe that this Australian Company has every likelihood of being a prosperous one. Messrs. Harrisson and Whiffen have done good work in Australia, and the business is rapidly growing. The Directors have every confidence in recommending subscription to the shares of that Company. I may mention that the Australian Company which has been formed, and of which I have agreed to be Chairman, is merely another form of having a house in Australia, where our business will be transacted perhaps better than if we merely had a firm out there to look after it. The Australian Company are bound to take all their material, &c., from Crompton and Company. At the date of the report only 16,781 shares had been allotted, but up to this date the shares placed number 18,816. There are thus less than 1,200 shares left, and no doubt they will be placed very shortly. I think it is a question whether we ought not to put a premium on the balance that we have still left. However, that is a matter the Directors will take into consideration. I understand that there is a question which has appeared to be rather of a knotty kind to some of the shareholders—the question, that is, of the patents and goodwill, the sum against that item being £37,765. That represents the value of the business over and above the actual realisable assets handed over to the Company by the vendors. If any gentleman would like to have any further explanation I would ask the secretary, who is well versed in the figures, to give the information. I now move the resolution.

Mr. R. E. B. CROMPTON: Gentlemen—In rising to second Lord Torrington's motion, I have great pleasure in addressing you for the first time since the formation of the Company, as I was unfortunately absent at the first meeting. Being the vendor, this might, of course, be a somewhat serious moment for me to meet you, the business having been turned into a limited liability company. I am, however, glad to say that I feel very comfortable in thus meeting you. The business I was very proud of as a private firm, and I am, and I believe I shall continue to be, equally proud of it as a limited liability company. There has been among some people a sort of prejudice against the Limited Liability Companies' Acts. They say that firms that have done extremely well as private firms do not continue to do so well when turned into limited liability companies. That statement has been frequently made, and I think in some cases it is only too true; but some of the finest businesses in this country are working on the lines we are working this Company on—that is, that the original owners who built up the business shall remain the principal shareholders, as is the case here. When I look at such firms as Messrs. Marshalls, of Gainsborough, the finest set of engineering works in the world, I only hope that we shall be able to follow in their footsteps, do equally good work, and gain such a world-wide reputation. I may say that the objects we had in view in obtaining additional capital by the formation of this Company have been already partially attained. We have been able to take up many large contracts which we could not have dreamt of when we were hampered for want of capital. As a result our order-sheet is better filled up than it was at any time since we commenced. I can corroborate every word your Chairman has said as to the hope of future prosperity. A firm situated as we are, with very considerable works and very considerable engineering power, have a revenue from two sources—keeping the works fully employed, and in the second place, turning the brains we may have to useful account. I refer more particularly to my co-director and myself and our superior engineers. It was not until the passing of the Electric Lighting Act that we were able to get any scope at all for that latter part of our assets, for it is an asset. All my training and all Mr. Albright's training has come from actual experience and spending our own money in the past; and such experience is now bearing fruit, for we are getting a line of orders which means very small risk to the Company's capital, and it brings in profits. We are ourselves doing our best to increase the number of electric light and supply companies, and we are in negotiation with several towns in addition to those named in the report, but for reasons which you will all appreciate we do not mention those towns here. They are not absolutely completed, and our rivals are very apt to step in and snatch the cup away from us before we get it to our lips.

Mr. R. TUFNELL inquired what percentage of depreciation had been charged for plant, buildings, &c. The £1,554 in the profit and loss account for depreciation appeared at first sight rather small on so large a sum as £44,133 standing in the balance-sheet as the value of the stock-in-trade, plant, tools, &c.

The SECRETARY stated that 2½ per cent. had been written off the buildings account, and 7½ per cent. off the plant and machinery. The auditors thought that 2½ per cent., considering that they kept the buildings of the company in repair, should not be continued in the future, and he (the speaker) agreed with them; but it had been thought advisable to make the depreciation in question on this occasion. As to the subject of patents and goodwill, referred to by the Chairman, there were many meetings and negotiations before the Company was formed, at which he (the speaker) was present, and that item stood at a very much larger figure in the original negotiations—as much as £70,000. It was originally intended that the preferred capital should be £70,000, and the ordinary capital £70,000, but the result of their negotiations satisfied those who were coming into the business that £70,000 would not be sufficient to provide for the purchase of the business and to furnish sufficient working capital. After negotiations, that sum was increased to £100,000, but the figure of £140,000 was retained, the vendors giving way to the extent of £30,000 of ordinary shares. The £40,000, taken as a round figure, was supposed to represent the actual value of the business other than realisable assets. The vendors desired to get an increased capital for extending the business, and they offered the large preferential dividend of 7 per cent. Having done that they thought they would be justified in retain a large holding as Ordinary Shareholders, and that amount was agreed, after considerable discussion, at £40,000. As, however, the actual realisable assets exceeded £50,000 by about £3,000, the £40,000 resolved itself into the figure in the balance sheet of £37,300.

A SHAREHOLDER: That represents the Ordinary Shares?

The SECRETARY: Yes.

Mr. ALBRIGHT stated that while in the office that morning a gentleman, who was one of the engineers of one of the most important South American Railways, came into the office and referred to certain orders that had recently been placed with them. He incidentally told the speaker that a plant, which their Company had supplied to his Company over two years ago—a considerable order—had already considerably more than paid for itself in the saving it had effected for them, owing to the fact that by using the electric light they could unload wagons and, generally speaking, carry on their business by night as well as day. The gentleman in question also stated that the Company's plant was so satisfactory to them that, although in sending out their tenders they had received tenders lower than those of the Company, they had unhesitatingly given their orders to those from whom they had received satisfaction in the past. The Company kept on receiving orders, but he did not think it was necessary to go into them. He thought that the particular incident he had mentioned might interest the shareholders.

The CHAIRMAN put the motion and it was carried unanimously. He afterwards stated that since the formation of the Company they had elected as Directors Mr. Bernard Gibson and Mr. Carleton Fowell Tufnell, two gentlemen who were likely to bring great strength to the Company, and he was sure they would materially advance its prosperity. They had been duly elected by the Board, but he would like to have their election confirmed by the shareholders.

On the motion of the Rev. O'BRIEN HODGE, seconded by Mr. J. HILL, a resolution was accordingly passed confirming the election of the gentlemen named.

Mr. R. TUFNELL afterwards moved, and Mr. HODGE seconded, the re-election of Messrs. Duncan, Bryce, and Co. as auditors, and the motion was agreed to.

A SHAREHOLDER inquired when the dividend would be paid.

The SECRETARY: This evening.

Mr. TUFNELL then proposed a vote of thanks to the Chairman and Directors for their able management of the Company's concerns.

Mr. HY. COX seconded the motion, which was carried unanimously.

The CHAIRMAN, in returning thanks, assured the shareholders that the Directors would do their best to promote the welfare of the Company.

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Their interests were identical with those of the shareholders. He could not let that opportunity pass without recognising the services of Mr. Reeves (the secretary), who was his (the Chairman's) other right-hand man.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

A half-yearly general meeting of the Company was held at the Cannon-street Hotel, on Thursday, "for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend of 5 per cent., or 10s. per share, free of income tax." Mr. S. William Silver presided.

The SECRETARY (Mr. Wm. J. Tyler) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I think I may say that we have pleasure in meeting you here to-day, and perhaps unusual pleasure. We have to report to you that the general trade has been quite equal, somewhat in excess, of that of any previous year. Our electrical and telegraph departments have been fairly occupied. Two of the steamers have been employed. One returned only last Saturday after laying little short of 1,000 miles of cable on very difficult ground. This expedition was under the direction of our engineer-in-chief, Mr. Hamilton Gray. It was successful in every respect, notwithstanding the peculiar character of the coast, ground seas, the delta of the Congo river, and the varying nature of the bottom—all showing us and the public generally that a practical knowledge of the manufacture of a cable is not only desirable but essential to carry out an undertaking, as this has been, in the most successful way, at once uniting practical knowledge with scientific skill. I take it upon myself to say that I think the Silvertown Works will not be found wanting in this respect. The preparations for the expedition, from the experience of our engineer, whose name I have given you, were such as afforded us every satisfaction in reference to the sanitary condition of those on board, and the whole work has been carried out in the most satisfactory way—well within the time—and efficiently in working. I therefore think you will say that we are thoroughly justified – or that I am as the representative of my friends here—in moving that a 5 per cent. dividend, or 10s. a share, free of income-tax, should be payable on the 12th inst.

Mr. MATTHEW GRAY: I second that.

The CHAIRMAN inquired if any shareholder had any question to ask, or any remark to make, and no one rising to address the meeting, he put the motion in the usual manner, and declared it carried unanimously, adding that that concluded the business.

Mr. J. L. HANSON said that before separating the shareholders had a duty to perform to the Directors, particularly after the satisfactory statement of the Chairman. He begged to move a vote of thanks to the Chairman and the Directors for the care and attention they had bestowed on the management of the Company's affairs, and also for the great success which appeared to result from their endeavours.

Captain VEREY said he had very much pleasure in seconding the resolution, but he thought they ought to include in the vote the name of Mr. Gray, who had so successfully looked after the expedition referred to by the Chairman.

The motion was carried unanimously.

The CHAIRMAN: I can only thank you in the name of my friends sitting on the right and left of me, and I will undertake to communicate Captain Verey's special rider to my young friend, Mr. Hamilton Gray, who richly deserves it. I should also like to include those who were with him, a careful body of men and the captain. I may say that the vessel returned to her moorings on Saturday last within an hour of the time appointed, the work having been carried out in the most successful way.

The meeting then separated.

The Eastern Telegraph Company (Limited).

Report and accounts of the Directors for the half-year ended 31st March, 1889, to be presented to the thirty-fourth half-yearly ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on Thursday, the 18th inst., at one o'clock:—

The revenue for the period amounted to £435,932. 3s. 10d., from which are deducted £92,448. 14s. 6d. for the ordinary expenses and £48,665. 14s. for expenditure relating to repairs, renewals, and laying of cables, &c., during the half-year. After providing £3,710. 5s. for income tax, there remains a balance of £291,107. 10s. 4d., to which is added £36,616. 1s. brought from the preceding half-year, making a total available balance of £327,723. 11s. 4d.

From this amount there has been paid—

Interest on Debentures and Debenture Stock	£28,274	13	2
Dividend on Preference Shares	20,474	2	8
An interim dividend of 1¼ per cent. on the Ordinary Shares	50,000	0	0
	£98,748	15	10

leaving a balance of £228,974. 15s. 6d., from which £118,000 has been carried to general reserve.

The Directors now recommend the declaration of a final dividend for the year ended 31st March, 1889, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on the 18th inst., free of income-tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year, on the Ordinary Shares. The balance of £974. 15s. 6d. shown at the foot of the revenue account is proposed to be carried forward to the next half-year.

The revenue includes £81,441. 12s. dividend and bonus for the half-year upon the Company's investments in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies.

Since the last general meeting, the Eastern and South African Telegraph Company has completed the extension of its cables along the West Coast of Africa, connecting Cape Town, Port Nolloth, Mossamedes and Benguella with Loanda, where the cables of the West African Telegraph Company terminate, thus establishing an alternative line of telegraphic communication between Europe and the Cape of Good Hope, and completing the telegraphic circuit of the African continent. The Directors believe that the accomplishment of this important work will be highly satisfactory to the shareholders of this Company, which is largely interested in the Eastern and South African Company, and to the public.

An agreement has been entered into between this Company and the other telegraph companies interested in the South African telegraph business, by which the telegrams to and from South Africa will be transmitted either by the East Coast or West Coast route on joint account, and the receipts divided between them in equitable proportions.

A convention has been entered into between the French Government and this Company for laying a cable between the Company's station on the island of Perim and the French settlement of Obock.

The several sections of this Company's cables are in good working order.

NEW COMPANIES REGISTERED.

THE CHILI TELEPHONE COMPANY (LIMITED).—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £250,000 in £5 shares. Object, to carry into effect an agreement made between W. A. Pittman and the Chili Telephone Company (Limited), and to purchase, acquire, construct, equip, maintain and work any lines of telegraph, telephones or other means of communication in Chili and the adjoining countries, and generally to carry on the business of a telegraph, telephone and electric light company. There shall not be less than three nor more than seven directors.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.

PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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The first to be appointed by the subscribers to the Memorandum of Association. Qualification £1,000 stock. Remuneration to be determined in general meeting.

CROYDON ELECTRIC SUPPLY COMPANY (LIMITED).—Registered by Saxelby and Faulkner, 7 and 8, Ironmonger-lane, E.C., with a capital of £5,000 in £5 shares. Object, to construct within the borough of Croydon works for distributing the electric light. Registered without Articles of Association.

DEVON AND CORNWALL ELECTRICITY SUPPLY COMPANY (LIMITED). Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Object, to form centres in Devon and Cornwall at which electric power may be generated or accumulated for the purposes of street, house lighting, &c. One of the first subscribers is Mr. R. Hammond, 117, Bishopsgate-street, E.C. There shall not be less than three nor more than seven directors. Qualification, £250 stock. Remuneration: £500 per annum divisible, and one-tenth of net profits after 7 per cent. dividend.

DUTTON AND CO. (LIMITED).—This company was registered on the 29th ult., with a capital of £60,000, in £10 shares, to acquire the business and goodwill of Dutton and Co., mechanical engineers, electricians, and signal manufacturers. The number of directors is not to be less than two nor more five; remuneration, £50, to be divided as they may determine.

ECUADOR TELEPHONE COMPANY.—This company was registered on the 4th inst., with a capital of £100,000 in £5 shares, to acquire or construct telegraphs, telephones, and other means of communication in Ecuador and the adjoining countries. The signatories and arrangements for management are the same as those of the Peru Telephone Company, a notice of which appears above.

THE HENLEY TELEGRAPH AND ELECTRIC CONSTRUCTION COMPANY (LIMITED).—Registered by Newman, Hays and Co., 31, Abchurch-lane, E.C., with a capital of £200,000 in £10 shares. Object, to carry on, as principals or agents, the business of electricians, telegraph engineers and contractors, submarine and telegraph instrument manufacturers, &c., and for the purpose to acquire lands, works, property, and premises wherever convenient, and the machinery and patent rights belonging to W. T. Henley's Telegraph Works Company (Limited), and the goodwill, property, and other rights connected therewith; to carry on the business of an electric light company in all its branches, and in particular to erect any works requisite for the business of the company wherever expedient and convenient. The first subscribers are:—F. Newton, 16, King William-street, E.C.; W. Hays, 31, Abchurch-lane, E.C.; H. Lescher, 6, Clement's-lane, E.C.; Lieut.-General Sir J. Stokes, K.C.B., Good Rest, Hayward's Heath; S. Gedge, M.D., 1, Old Palace-yard, Westminster; G. Baird, C.E., Travellers' Club, Pall-mall; The Hon. H. S. Littleton, 22, Rutland-gate, S.W. There shall not be less than three nor more than nine directors. The first to be appointed by the subscribers to the Memorandum of Association. Qualification, 50 shares. Remuneration, £2,000, and further £150 for every 1 per cent. of dividend over 10 per cent.

THE KINGSTON-UPON-HULL ELECTRIC LIGHTING AND SUPPLY COMPANY (LIMITED).—Registered by F. B. Moss, the Outer Temple, Strand, W.C., with a capital of £1,000, in £1 shares. Object, to establish at Kingston-upon-Hull an electric light company. Registered without Articles of Association.

LEICESTER ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—Registered by Walter Webb and Co., 23, Queen Victoria-street, E.C., with a capital of £1,000 in £10 shares. Object: To produce and supply electricity or electrical currents, and to undertake public or private lighting. Registered without articles of association.

SCHOTH'S ELECTRO-MEDICAL APPARATUS COMPANY (LIMITED).—Registered by Danell and Co., Finsbury-chambers, E.C., with a capital of £10,000 in £1 shares. Object: To carry on all the businesses hitherto carried on by G. A. Schoth, of Euston-road, for manufacturing electro-medical and scientific instruments, and also the manufacture of medical and surgical instruments. Registered without Articles of Association.

THE PERU TELEPHONE COMPANY (LIMITED).—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Object, to carry into effect an agreement made between W. A. Pittman and the Peru Telephone Company (Limited) to acquire any lines of telegraphs and telephones in Peru. There shall be not less than three nor more than seven directors. Qualification, £1,000 stock; remuneration to be determined in general meeting.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended July 5, 1889, amounted to £4,068.

CUBA SUBMARINE TELEGRAPH COMPANY.—For the month of June the receipts of this Company show an increase of £273 as compared with the corresponding period.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.—The directors of this company have, subject to audit, decided to recommend at the meeting of shareholders to be held on the 30th inst. a dividend of 7 per cent. for the year ending 30th June, 1889, on the A shares, and a further distribution of 3 per cent. against arrears of cumulative preferential dividend on those shares.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company for the month of June, 1889, amounted to £22,600. From the 1st January to 30th June, 1889, they were £129,400, against, in the corresponding months of 1888 and 1887, £132,000 and £127,120 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 5, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,791.

WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—At the Board meeting, held on Wednesday last, the directors declared an interim dividend of 5s. per share, free of income-tax, in respect of the first half of 1889, payable on the 18th inst.

NATIONAL TELEPHONE COMPANY (LIMITED).—It is stated that . F.Mr R. Leyland has been elected president, and Colonel R. Raynsford Jackson and Mr. James Staats Forbes have been elected vice-presidents of this company. The registered offices of the company have been removed from 162A, Queen Victoria-street, to Oxford-court, Cannon-street, London, E.C.

PERSONAL.—We are informed by Mr. A. H. Vesey, A.M.I.C.E., that he has taken offices at 12, Draycott-place, Sloane-square, S.W. Mr. Vesey, we are glad to learn, has several important installations on hand at present, amongst which are Prince's Club and Brooks' Club.

——— The firm of Siebe, Gorman and Co., of Westminster Bridge-road, submarine and electrical engineers, has been dissolved. Mr. W. A. Gorman will carry on the business in future by himself.

DISSOLUTIONS OF PARTNERSHIP.—The dissolution of the partnership between Messrs. A. Thompson and Robert T. Turnbull, electrical engineers, of Connaught-mansions, Victoria-street, London, S.W., was announced in Tuesday's *Gazette*.—The Hon. C. A. Parsons has retired from the firm of Messrs. Clarke, Chapman, Parsons and Co., of Gateshead-on-Tyne, by mutual consent, and under the style of Messrs. C. A. Parsons and Co., of Park-lane, Gateshead-on-Tyne, will carry on the electrical branch of the business of the original firm, who will in future be known as Messrs. Clarke, Chapman and Co.

REMOVAL.—Messrs. Spagnoletti and Crookes inform us that they have removed their offices and factory from Adelaide Works, Uxbridge-road, to larger premises at Goldhawk Works, 39B, Goldhawk-road, W.

CRICKET.—The following matches, which have been recently played by the Carcavellos Club (Eastern Telegraph Company's Station), will be of interest to some of our readers:—May 30, Carcavellos *v.* Victoria—Carcavellos, 108 and 93; Victoria, 63 and 93. June 13, Carcavellos *v.* Lisbon—Carcavellos, 208; Lisbon, 45 and 78. June 20, Carcavellos *v.* Victoria—Carcavellos, 194 and 13 (for one wicket); Victoria, 65 and 141. June 28, Carcavellos *v.* Lisbon—Carcavellos, 86 and 122 (for four wickets); Lisbon, 132 and 72.

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PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

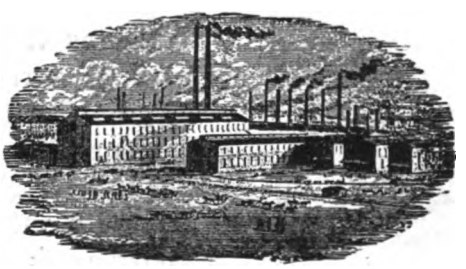
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, July 10, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 10, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	2½%	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	53½	...
2,614,820	Stock	5%	Do. Preferred	90 91	4 7 11	" "	91½	90⅝
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	18⅞	18½
130,000	£10	10%	Brazilian Submarine	13 13⅛	5 3 8	Mar., June, Oct., Dec.	13⅜	13
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	..	...
16,000	10	9%	Cuba Submarine	14⅜ 15½	5 18 0	February and August	...	...
6,000	10	10%	Do. Preference 10%	19⅝ 20⅛	4 17 7	" "	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4½	4 4 8	March & September	...	...
6,000	5	10%	Do. Preference 10%	8½ 9⅜	5 5 3	April and October	...	...
60,710	20	3½%	Direct United States	10⅞ 11	5 0 0	Jan., Apr., July, Oct.	10⅞	10⅞
380,000	10	5%	Eastern	13¼ 13½	4 8 11	" "	13⅜	13¼
70,000	10	6%	Do. 6 per Cent. Preference	14⅝ 15½	3 18 8	" "	15⅜	15⅛
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	4 10 1	February & August	110	109½
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13½
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	104 106	5 13 2	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	103½	...
179,177	10	6%	Globe Telegraph and Trust	8⅛ 8⅜	4 14 3	Jan., Apr., July, Oct.	8⅝	8½
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 15	4 0 0	" "	15	14⅞
150,000	10	7½% for '88	Great Northern	15½ 15⅝	4 16 9	Jan., July, and April	15½	...
17,000	25	15%	Indo-European	39 41	6 1 11	April and October	...	...
9,000	8	5%	Reuter's	6⅜ 7½	5 10 2	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
80,000	10	6% for '88	West Coast of America	9⅜ 10½	5 17 4	January and July	...	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2½	2⅜
34,563	10	12/0*	Do. 1st Preference 6%	11¾ 12¼	...	April and October	12	...
4,669	10	...	Do. 6 per Cent. 2nd Preference	14 15	...	...	14⅛	...
45,181	15	6%	Western Brazilian	11 11⅛	6 10 4	March & September	11⅛	10⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	7%	Consolidated Telephone and Maintenance ... xd	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅛ ⅜	4 8 3	...	...	...
80,000	5	25%	United xd	14¾ 15½	5 14 9	June and December	15⅛	14½
55,000	5	3/0	United River Plate	6 6½	...	January and July	6⅜	...
			ELECTRIC LIGHT.					
23,003	5	...	Anglo-American Brush (£4 paid)	3½ 4	...	...	...	...
23,692	5	...	Do. (fully paid)	4⅛ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	3⅞ 4	...	...	4	3⅞
			MISCELLANEOUS.					
37,350	12	30/0	Telegraph Construction and Maintenance	42 44	5 6 3	March and July	43½	42¾
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19¾	...

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

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NOTES.

The Report issued by the Board of Trade at the beginning of the month respecting its proceedings under the Electric Lighting Acts forms a concise summary of the steps taken during the past twelve months by the Board of Trade with regard to the applications of the various electric lighting companies, the chief facts of which are already well known to our readers. After giving a list of the applicants for Provisional Orders, and referring to the "Model Order" and the correspondence thereon with the London County Council, the Report proceeds as follows:—"Some of the alterations, however, which proposed to extend the jurisdiction of the County Council, or to transfer to it duties entrusted by Parliament to the Vestries or District Boards as the local authority, the Board of Trade were unable to concur in. They considered that such substantive changes in the existing law should not be effected by a Provisional Order, but, if necessary, should be carried out by an Act of Parliament of general application, after full discussion." We are extremely glad to find that the Board of Trade is after all of our opinion on this point, although it is rather difficult to reconcile its statements with its actions.

The wholesale transfer to the London County Council of "duties entrusted by Parliament to the Vestries" which formed such a marked feature of the "Model Order" forms if anything a still more marked feature of the batch of Provisional Orders now before Parliament, the name of the County Council occurring at least a dozen times in these Orders where it did not occur in the Model Order. The alterations in the Orders granted by the Board of Trade, although not of the first importance, tend so far as they go to place the Undertakers in a less advantageous position than they held under the Model Order. For instance, the County Council may now, with the approval of the Board of Trade, prescribe the hours during which the Undertakers are to carry out work in connection with distributing boxes. Again, any person demanding an electric supply has now only to contract for a minimum of two years instead of three years. On the other hand, the County Council, which was empowered by the Model Order to summarily remove and sell, after the manner of the New York Board of Control, all overhead wires which were still in position at the end of two years, is now obliged to attain the desired result by the less exasperating process of fine. It is, we think, to be regretted that more alterations of this character have not been made in the Orders now before the Select Committee.

With regard to some of the numerous electric lighting projects in the provinces announced in our last week's issue, we confess to a feeling of uneasiness. Many of the companies are, no doubt, perfectly sound and honest concerns, but others were never heard of till yesterday, and their intended *modus operandi* remains an unknown quantity. The question of *personnel* is one of no small importance—from our point of view the name and record of the engineer and electrician of a Construction Company, to say nothing of the promoters, are second only to the question of the soundness of its finance. And even with Supply Companies who do not necessarily design or erect their own central stations the difficulty of finding a thoroughly capable technical staff will sometimes be seriously felt. In most cases we suppose that the task of laying (as well as maintaining) the underground mains will devolve upon the local electricians, so that men with any real experience in this direction should find themselves shortly at a premium. Our chief anxiety is that the best men should fill the best posts, and that directors should realise more thoroughly than at present they seem to do the vital importance of the appointments which they have to fill. As regards some of the promoters, it is hard to say whether the public is most to be admired for its short memory or its long suffering. We can only stand by and silently wonder.

We have remarked in our leading column on the admirable way in which the accounts of the London Electric Supply Corporation were rendered at its general meeting last Monday. Both in form and in matter they are a pattern of what such accounts ought to be. The Act of 1882 requires that electric supply companies shall furnish their accounts on a model approved of by the Board of Trade. This model ought, we think, to be of uniform application. The balance-sheet and accounts referred to, we are informed, have been issued with the Board's approval; and we should say that it could not do better than adopt it as a model for the guidance of all the other supply companies.

Having safely established its monopoly of manufacture, the Edison-Swan Company has celebrated the event by issuing a new and revised price list. Naturally the trade would expect that after beating all its opponents in the Law Courts and obtaining the costs of its litigation the victorious company would signalise its triumph by reducing its charges; and so it has. Prices are reduced, *but so are the discounts.*

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We should be sorry to see the Technical Education Bill, which has now reached the Committee stage, either rejected or delayed through any cause whatever; but the display of animosity on Monday evening when an amendment extending the scope of the Bill to Voluntary Schools was hotly opposed might well justify its withdrawal if anything could. Lord Hartington took fright at the suggestion, regretfully predicting that the Bill, if saddled with that provision, would not be allowed to pass either this session or the next. And apparently he was right, for there immediately followed not merely predictions but threats that the Government should rue it if the attempt to place Voluntary Schools on a footing with Board Schools proved successful. On the other hand, the friends of Voluntary Schools were equally determined the Bill shall not pass unless the equality they demand is conceded.

Between the two contending parties the Bill may probably be sacrificed; and almost certainly will exclude Voluntary Schools from its operation if carried. A deplorable example of partisan and sectarian animosity is revealed in this otherwise ridiculous squabble. Both sections are anxious to provide technical instruction; but one of them is even still more anxious that the other shall get none of the State help which is to be liberally given to itself. In other words, technical education is good for the rising generation, but not for those who attend other than Board Schools. This attitude might be pardonable if Voluntary Schools were entirely self-supporting, for then they could expect no external assistance for technical any more than for ordinary schooling. But in reality considerable grants in aid are annually voted by the State to Voluntary and Board Schools alike, where the educational standard required by the State is maintained. This being the case, it is logically impossible to withhold from Voluntary Schools the assistance for technical instruction accorded to Board Schools under the present Bill. The claims of Voluntary Schools appear still stronger when we remember that they cost the nation extremely little although they do a large proportion of the educational work of the country.

In an article on Electric Radiation in the current number of the *Phil. Mag.*, Dr. Lodge observes that an electrostatic charge upon the surface of the sun would if disturbed oscillate to and fro with a period of 6·6 seconds. He therefore suggests that "It may be worth while to suspend at Kew a compass-needle with a natural period of swing of 6·6 seconds, and see whether it responds to solar impulses." These waves would be twelve hundred thousand miles in length. A charge upon the surface of the whole earth would have a period of only one-seventeenth of a second, so that it would be somewhat difficult though not perhaps impossible to detect its presence in this way. Prof. J. J. Thomson has calculated that the period of oscillation of an electrostatic charge upon a conducting sphere is equal to 1·4 times the time taken by light to traverse the diameter of the sphere.

Our New York correspondent this week gives a brief description of a very simple method which has been devised by Mr. Nikola Tesla to start a synchronising motor and bring it to synchronism without external aid. Ingenious as the system is, we do not think it will meet with much favour in this country, since it involves the use of an earth return during the period of starting.

Hamburg.—This town has just voted £11,000 for lighting the two Jungfernstiege of the Alsterdamm.

The Scotch Universities Commission.—Sir Wm. Thomson has been appointed a member of the Scotch Universities Commission.

Chesterfield.—Messrs. Crompton and Co. have applied for powers to supply electricity in the Borough of Chesterfield for public and private purposes.

Rochdale.—Three electric lighting companies have announced their intention to the Town Council of applying for powers to supply electricity within the borough.

Rugby.—A notice has been received from the Midland House-to-House Electricity Company of their intention to apply to the Board of Trade for a Provisional Order.

Darwen.—The Municipal Electric Power Corporation have caused a notice to be served upon the Town Council of their intention to apply for a Provisional Order.

Cape Town.—The Cape Town Council has refused to grant to a local firm a concession for ten years of the exclusive right of supplying the electric light in Cape Town.

Poplar.—The Metropolitan Electric Supply Company have intimated their intention to apply for powers to supply electricity within the district of Poplar Board of Works.

Airdrie and Coatbridge.—The Lighting Committee have been instructed to consider and report upon the proposals of the Scottish House-to-House Electricity Company.

York.—Six electric lighting companies have given notice to the Town Council that they propose to apply for Provisional Orders authorising them to supply York with electricity.

Kidderminster.—The Western House-to-House Electricity Company have intimated their intention to apply for a Provisional Order for the supply of electricity within the borough of Kidderminster.

Incandescent Lamps and Lamp Holders.—The Edison-Swan Company have just issued a new illustrated circular list of prices and particulars of their well-known incandescent lamps, lamp holders, &c.

Crediton.—At the last meeting of the Crediton Improvement Commissioners a letter was read from the Devon and Cornwall Electric Lighting Company announcing their intention to apply for Parliamentary powers.

Barry.—The lighting of the new docks at Barry Island has been carried out by Messrs. Crompton and Co., who have installed 41 3,000 candle-power arc lamps, and 600 16 candle-power incandescent lamps.

Winter Sessions.—The 1889-90 Session of University College, Bristol, opens on the 9th October. Full particulars respecting the Electrical Engineering course will be found in our advertisement column.

Leith.—Five electric lighting companies have given notice to the Leith Town Council that they intend to apply for Provisional Orders. The matter has been remitted to the General Committee for consideration.

London Chamber of Commerce.—The following, amongst many others, were elected members of the London Chamber of Commerce at the last Council Meeting:—The Westinghouse Electric Company; James Taylor (Telegraph Manufacturing Company, Limited), Telegraph Engineer; and Richd. S. Waring (Waring Cable Company), Electric Wire and Cable Manufacturer.

Smethwick.—Notice has been served on the Smethwick Local Board by the Midland House-to-House Electricity Company that

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they intend applying to the Board of Trade for powers to supply electricity in Smethwick.

Fleetwood.—The Fleetwood Improvement Commissioners have resolved to hold a special meeting to authorise an application to the Board of Trade for powers to supply electricity for public or private purposes in the district.

Middlesborough.—A communication from the Yorkshire House-to-House Electricity Company has been received by the General Purposes Committee, in which the Company gives notice of its intention to apply for a Provisional Order.

Hamilton.—The Scottish House-to-House Electricity Company having intimated that they intend applying for a Provisional Order to introduce electric lighting into the town, it has been resolved that the Town Council should themselves apply for an Order.

Keighley.—Two electric lighting companies have given notice to the Town Council of their intention to apply for Provisional Orders. The Town Clerk has been instructed to inform them that their proposals will be strongly opposed by the Corporation.

Newcastle.—At a meeting of the Newcastle Town Improvement Committee on Wednesday last week notices were given of applications on behalf of two electric light companies. The two companies referred to are independent of the two companies already established.

Simla.—Various improvements, says *Indian Engineering*, are being introduced in the Viceregal Lodge at Simla. The lodge is being connected by telephone with the Foreign Office, and a wire will probably be carried on to the Home Office, which is distant about two miles.

Canterbury.—Notices have been received by the Town Council announcing the intention of the Electric Construction and Maintenance Company, and of the South of England House-to-House Electricity Company, to apply for powers to supply electricity within the district.

Burslem.—The Town Council has received notices from the Midland House-to-House Electricity Company and the Municipal Electric Light and Power Corporation of their intention to apply for Provisional Orders authorising the supply of electricity within the borough.

Glossop.—A notice has been received by the Town Council from a London electric lighting company stating their intention of applying to the Board of Trade for powers to light the Borough of Glossop with electricity. A resolution was passed inviting the company to carry out their project.

Halifax.—Communications were read at the last meeting of the Town Council from the Electric Construction and Maintenance Company and the Yorkshire House-to-House Electricity Company, announcing their intention to apply for Provisional Orders to supply electricity within the borough.

Crumpsall.—At the last meeting of the Crumpsall Local Board the Clerk stated that he had received a communication from the Manchester House-to-House Electric Company giving notice of their intention to apply for a Provisional Order, and asking the consent of the Board to the application.

Haslingdon.—At the last meeting of the Haslingdon Local Board the Clerk read a communication from an electric lighting company with registered offices in Bond-street, giving notice that they intended to make application for a Provisional Order. The matter was referred to the Lighting Committee.

Ipswich.—At a meeting of the Ipswich Paving and Lighting Committee last week, the Clerk read a communication from the Midland House-to-House Electric Company, giving notice that they intended to apply for a Provisional Order, and asking the formal consent of the Corporation to such application.

Barnsley.—At the meeting of the Town Council on Wednesday the Town Clerk reported that he had received notices from the National Electric Company, the Yorkshire House-to-House Electricity Company, and the Municipal Electric Light and Power Corporation, of intention to apply for Provisional Orders.

The City of London.—The Anglo-American Brush Electric Light Corporation, the Metropolitan Electric Supply Company, and the Laing, Wharton, and Down Construction Syndicate have given notice of their intention to apply to the Board of Trade for Provisional Orders to supply electricity within the City of London.

Kirkcaldy.—At a meeting of the Kirkcaldy Town Council on Monday last week, the clerk reported that he had received notice of the intention of the Scottish House-to-House Electricity Supply Company to apply for a Provisional Order. After some discussion the matter was remitted to a committee to inquire into. The Committee subsequently advised the Council to oppose the application, and this was agreed to.

Hanwell.—At the last meeting of the Hanwell Local Board notices were received from the South-Western District and Thames Valley Electric Supply Company and from the Electric Supply Corporation to the effect that they intended to apply for Provisional Orders for the purpose of introducing electric lighting into the Board's district.

Okehampton.—The Okehampton Town Council has referred to a committee a communication from the Devon and Cornwall Electricity Supply Company, asking for the consent of the Council to an application of the company to the Board of Trade for a Provisional Order to authorise the supply of electricity for public and private purposes within the borough.

Electric Traction on the Underground Railway.—In the report of the Metropolitan Railway Company, issued this week, it is announced that the agreement with the Electric Traction Company has been cancelled, and an offer is now under consideration from another quarter to make a trial without cost to the railway of a direct system of electric traction.

Liskeard.—At the last meeting of the Town Council a communication was received from the Devon and Cornwall Electricity Supply Company, soliciting the consent of the Council to an application to the Board of Trade for a Provisional Order authorising the company to supply electricity for public and private purposes in the urban district of Liskeard. It was decided to defer giving consent.

Limehouse Board of Works.—At the last meeting of this Board, notice was received from the Solicitors to the Metropolitan Electric Supply Company that application is intended to be made for a Provisional Order for the Limehouse District. A similar notice was received from the Solicitors of the London Electric Supply Corporation. The communications were referred to the Works Committee.

Brussels.—The electric lighting tenders have now been opened. Six offers were received. The firms tendering were l'Electrique, of Brussels, the Compagnie Internationale d'Electricité, of Liège; the Züricher Telephongesellschaft; M. van Rysselbergh, the Thomson-Houston Company, and Messrs. Siemens and Halske, of Berlin. The tenders have been taken into consideration, and will be reported upon by the Municipal College.

Withington.—At the last meeting of the Withington Local Board the Highways Committee reported that letters had been received from the Anglo-American Brush Electric Light Corporation and the Manchester House-to-House Electricity Company announcing their intention to apply for Provisional Orders to enable them to supply the district of Withington with the electric light. The clerk was instructed to ask for further information.

Cardiff.—A special meeting of the Cardiff County Council has been summoned for the 12th August next to consider the notices of the five electric lighting companies who have announced their intention to apply for Provisional Orders. The Companies are Messrs. Crompton and Co., the Western House-to-House Electricity Company, the Anglo-American Brush Electric Light Corporation, the Electric Construction and Maintenance Company, and the Electric Trust.

Walsall.—The South Staffordshire Electric Lighting Company, the Midland House-to-House Electricity Company, and the Wolverhampton Electric Light and Power Company, have given intimation of their intention to apply to the Board of Trade for Provisional Orders authorising them to supply electricity for private and public purposes in Walsall. A Sub-Com-

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mittee has been appointed to consider the question of the desirability of an application by the Corporation for a Provisional Order.

Chatham.—At a meeting of the Chatham Board of Health on Friday last, notices were read from the Municipal Electric Light and Power Corporation, the South of England House-to-House Electricity Company and the Electric Construction and Maintenance Company, stating their intention to apply for powers to supply electricity for public and private purposes within the district of Chatham. It was decided to acknowledge the letters and ask each company to forward a copy of their Order.

Blackburn.—Four electric lighting companies have given notice to the Corporation of their intention to apply for powers to supply electric light in the borough. The companies applying are the Municipal Electric Light and Power Corporation, the Electric Construction and Maintenance Company, the National Electric Supply Company, and the Lancashire and Cheshire House-to-House Electricity Company. The Corporation are about to consider the advisability of themselves applying for the necessary power.

The Winner of the Queen's Prize at Wimbledon.—Sergt. Reid, 1st Lanark Engineers, the winner of the Queen's Prize this year with the remarkable aggregate score of 281, is a telegraph clerk in the Glasgow Post Office. The only other telegraphist, so far as we can learn, who won a respectable position in the contest, was Sergt. Tee, Post Office Volunteers, an Instructor in the London Telegraph School, who scored 83 in the first stage, only one point short of the score which would have carried him into the second stage.

Paper Electrical Torpedoes.—Experiments have recently been made at Kiel by the German naval authorities on torpedoes made of paper and worked by electricity. The results are said to have been very satisfactory. The torpedo is about 11ft. long by 16in. diameter, and is made of twelve layers of paper 3½ millimetres (·14in.) thick, compressed and varnished. The motor is mounted on three paper ribs, and driven from the ship or shore by a cable, the steering and ignition of the charge being controlled through the same cable.

Hull.—At the last meeting of the Corporation Works Committee, the Town Clerk reported that he had been served with notices on behalf of five companies, stating that it is their intention to make application for Provisional Orders to authorise them to supply electricity for public or private purposes within the borough. The companies are as follows:—The Yorkshire House-to-House Electricity Company, the Kingston-upon-Hull Electric and Supply Company, the National Electric Supply Company, the Electric Construction and Maintenance Company and Crompton and Company.

The Belgrano (Buenos Ayres) Gas Company Bill.—The second reading of this Bill, which gave the Company power to supply electric light as well as gas in Buenos Ayres, was moved in the House of Lords on Friday evening last. The Earl of Morley said if this Bill were passed he thought it probable that other Bills receiving less support from shareholders would be introduced. The Lord Chancellor pointed out that if the Bill passed it would be difficult in future for the Chairman of Committees to clearly define his duty with regard to similar measures. The Bill was finally negatived.

The Influence of Humidity on Bifilar Suspensions.—While recently engaged in some magnetic investigations, M. Marchand, of the Lyons Observatory, noticed that the relative humidity of the room had a very marked influence on the indications of the magnetometer. In fact, when the dampness increases the bifilar suspension lengthens, the tension diminishes, and there is an apparent increase in the horizontal component of the earth's magnetism. M. Marchand is of opinion that this effect probably accounts for the connection which has been observed between the variations of the magnetic elements and meteorological changes.

Severe Thunderstorms.—Several thunderstorms of great severity have occurred during the past week in the Midlands and in the North. At Taddington (Beds.) a haymaker was killed by lightning. On Saturday a heavy thunderstorm broke over Luton and district, and a farm-house was set on fire. On the same evening a severe thunderstorm passed over Northampton, doing great damage, and at a village two miles outside the town a man was killed. On Monday, Annan was visited by a thunderstorm which lasted several hours. The village school of Dornock, near Annan, was struck by lightning and 18ft. of the roof torn off.

Burton-on-Trent.—At the last meeting of the Town Council the Gas Committee reported that they had received notice from three different companies of their intention to ask for powers to introduce the electric light into the town. The Committee considered that it was advisable for them to take some action with a view to retaining such powers in their own hands. They had therefore instructed inquiries to be made at large centres where the electric light was used. The three companies applying are the South Staffordshire Electric Lighting Company, Crompton and Co., and the Midland House-to-House Electricity Company.

Ayr.—Notices having been sent to the Ayr Town Council by the Scottish House-to-House Electricity Supply Company and by Messrs. Norman and Son, intimating that they intended to apply for Provisional Orders, the Lighting Committee reported that it was undesirable to allow any company or person not under the control of the local authority to obtain the extensive powers which the Board of Trade's license would confer, and they recommended the Commissioners themselves to apply to the Board of Trade for authority to supply electricity for public and private purposes within the Burgh of Ayr. This report was approved at the last meeting of the Town Council.

The Incandescent Lamp Agreement.—We have received a circular from the Anglo-American Brush Corporation, in which they notify that, under the arrangement they have come to with the Edison Swan United Electric Light Company, they discontinue the manufacture of Victoria incandescent lamps in the United Kingdom, and that with regard to the Victoria incandescent lamps now in use, the arrangement is that their customers shall not be disturbed or prevented from using such lamps, unless the Edison-Swan Company wish to replace them by lamps of their own manufacture, in which case they shall carry out the substitution without charge to the customers of the Corporation.

Paris Meeting of the Institution of Electrical Engineers.—The following circular has been issued to the members of the Institution, and the meeting will doubtless be well attended:—

"Dear Sir,—I beg to inform you that a joint meeting of the Institution and the Société Internationale des Electriciens will be held at Paris on Friday, the 23rd August, to be followed on subsequent days by excursions to places of scientific interest. As it is necessary in completing the arrangements that the Council should know how many members will probably attend, I have to request that if you purpose doing so, you will intimate such intentions on or before the 20th inst. A programme of the meeting will be issued, as early as circumstances will permit, to those members who advise me that they purpose attending it.—I am, dear Sir, yours faithfully, F. H. Webb, Secretary."

The Proposed Exhibition at Edinburgh.—At the last meeting of the Edinburgh Town Council the recommendations of the Lord Provost's Committee, that the Council should decline the request of the secretary of the proposed Exhibition to grant the use of the East Meadows as a site for the Exhibition, and that a sum of £1,000 should be voted to the guarantee fund provided the magistrates and council were satisfied as to the site and other arrangements, were agreed to. At the meeting of the Executive Committee of the Exhibition on Monday it was announced that the question of site would be settled in a day or two, and that subscriptions would shortly be invited. Sir Thomas Clark, Bart., has accepted the office of Chairman of the Executive Committee, and Mr. Lee Bapty has been appointed General Manager.

An Electric Scrutineer.—An apparatus has been devised by M. Le Goaziou, and has been favourably reported on in the French Chamber, to indicate the total of "ayes," "noes," and voluntary abstentions from voting whenever a division takes place in the Chamber. On every desk in front of a

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member is placed a small box fitted with two handles, which the member works when registering his vote. The right handle registers his "aye," the left his "no," and both moved simultaneously indicate his abstention from voting. The results are printed by means of electro-magnets in a receiver, and are visible at a glance. Provision is made for a member to recall and correct his vote during the time allowed for the purpose.

Annual Excursion of the Liverpool Electric Supply Company's Staff.—The annual excursion of the staff and workmen of the Liverpool Electric Supply Company (Limited) took place on Saturday last. A number of Messrs. Callender's men also joined the party, which left Liverpool for Llandudno at an early hour. The dinner was held at the Westminster Hotel. Toasts were proposed to the Managing Directors, Messrs. Holmes and Vaudrey, and the Works Manager, Mr. A. Clough. The chairman (Mr. B. H. Collins) in a short address referred to the satisfactory growth of the company's business, and trusted it would still further increase now that a firm footing had been established in Liverpool as regards electric lighting. Boat-racing and other amusements were next indulged in, and the party then returned to Liverpool.

Fatal Accident at Brighton. — An inquiry was held at Brighton on Monday evening into the death of a man who had lost his life by coming into contact with an electric light wire. The deceased, Thomas Garman, was night watchman at Messrs. Hallett and Abbey's Brewery, and it was part of his duty to go to the roof to examine the liquor vat. Suspended at a height of between four and five feet over the stand from which this inspection was made was an electric light wire, and on Monday morning Garman was found lying there dead, with a mark half way round his neck as if grazed by the wire. A medical examination proved the man to have been perfectly healthy, and it was the opinion of Dr. Lowe that Garman had been killed by the electric current, his neck by some means coming in contact with the wire. The jury returned a verdict accordingly, and expressed an opinion that the wire, which had no communication with the brewery, had been very unsafely hung.

The London County Council.—At the meeting of the London County Council last week, the Highways Committee reported that notices of applications to be made next year for Provisional Orders had been received from the following companies:—Chelsea Electricity Supply Company, for Kensington, and St. George's, Hanover-square; Electricity Supply Corporation, for St. Giles's, Strand, Paddington, and St. Martin's-in-the-Fields; House-to-House Electric Light Supply Company, for Wandsworth, Fulham, and Lambeth; the Laing, Wharton, and Down Construction Syndicate, for the City of London; London Electric Supply Corporation, for the area of which the Council is the local authority; Metropolitan Electric Supply Company, for certain streets and places to be hereafter specified; Messrs. Renshaw, King and Co., for St. Margaret and St. John, Westminster; The Westminster Electric Supply Corporation, for St. Margaret and St. John, Westminster, St. George's, Hanover-square, St. Marylebone, and Paddington; a company (about to be formed) for Hampstead, Paddington, St. Luke's, Shoreditch, Clerkenwell, St. Marylebone, Kensington, Islington, Bethnal Green, Fulham, Hammersmith, Whitechapel, and Hackney.

Electrical Communication with Light-Vessels.—As long ago as the 22nd of February, 1887, a Committee was appointed by the Board of Trade to inquire into and report on the desirability of electrical communication between light-vessels and the shore, with the special object of facilitating the saving of life at sea; whether the system should be extended to lighthouses, and in other ways: and whether the experience gained by the present cable to the "Sunk" light-vessel has proved of sufficient value to justify the cost. The Committee (of which the Earl of Crawford was chairman), have presented their second and final report, which is now published as a Parliamentary paper. Herein they state that though the experiments carried on for the last four or five years show the possibility of establishing electrical communication, they remain of the same opinion as when they made their former report—that the expenditure involved in maintaining electrical communication between the "Sunk" lightship and the shore is not commensurate with the advantages gained, and they therefore recommend its discontinuance, and that the system should not be extended to lighthouses. They add that it would, as a general rule, be unadvisable to permit lightships which may be electrically connected with the shore to be used also as signal stations for commercial purposes. Sir Edward Birkbeck, M.P., who was on the Committee, dissents in one respect. He is strongly of opinion that a much more extended trial of the present electrical communication with the "Sunk" lightship should be carried out, and that for a further period of not less than five years.

Electric Lighting at Munich.—Dr. Voit, of Munich, has made a report to the Union Polytechnique showing the continued and increasing progress of the electric light. Nine electrical companies, three of which are especially interested in the municipal undertaking, have put down, for the lighting of Munich and its environs, 116 installations, comprising 588 arc lamps and 23,231 incandescent lamps, of which 4,900 are taken by the three Royal Theatres. Taking, from data furnished by the manufacturers, the mean candle-power of the arc lamps as 900, and that of the incandescent lamps as 16, the total quantity of candle-power supplied by the arc lamps is 529,200, and by the incandescent lamps 371,696, or adding the two together, a total quantity of 900,896 candle-power. There are 256 arc lamps and 6,687 incandescent lamps worked from gas-engines; 233 arc lamps and 14,610 incandescent lamps worked from steam-engines; and 90 arc lamps and 1,934 incandescent lamps worked by hydraulic power. The following table shows the candle-power obtained with each type of motor:—

Type of motor.	Candle-power from arcs.	Candle-power from incandescents.	Total candle-power.
Gas-engines	230,400	106,992	337,392
Steam-engines	209,700	233,760	443,460
Hydraulic motors.....	89,100	30,944	120,044

From statistics given by M. Diehl, it appears that in 1885 Munich had 30 electric-lighting establishments supplying 133 arc lamps and about 3,770 incandescent lamps. Reckoning as before the candle-power of each arc lamp as 900 and that of each incandescent lamp as 16, the light supplied by the arc lamps amounted to 99,700 candles, and by the incandescent lamps to 60,320, making a total of 160,020 candles. It will thus be seen that from 1885 to 1888 the quantity of light obtained from electricity rose from 160,020 to 900,896 candles.

Electrical Utilisation of Galvanisers' Waste Acid.—A correspondent of the *Engineer* says:—"In addition to the scheme mentioned last week for the utilisation of waste acids from galvanising works, which is the invention of Mr. Thomas Turner, Demonstrator in Chemistry at Mason College, another method of treatment has been discovered, and is now being perfected, by the chief chemist of Messrs. Elwell-Parker, Electrical Engineers, Wolverhampton. This latter scheme contemplates the treating of the waste acids mainly by electricity, and experiments have been proceeding for some time past with, it is understood, eminently encouraging results, which have been protected by patent. It seems likely that both inventors will have full opportunity afforded them of putting their discoveries to thorough trial, since Mr. Turner's method is likely to be taken up by some of the leading Birmingham sheet-iron galvanising firms, while that of the Electrical Engineering Company is intended to be taken up in a practical manner by certain of the Wolverhampton galvanisers. The system of adoption pursued in each case will probably be the granting of rights to several galvanising firms to carry out the process at their own works under royalty. What the merchantable products of the new processes are is at present a secret; but they are understood to be chemicals for which there is a large demand. Galvanisers, however, are glad to be promised relief from their troublesome 'pickle,'" We need scarcely say that this is by no means the first attempt which has been made to obtain some commercial return from the acid sulphate of iron which is produced in such enormous quantities in the process of cleaning or pickling iron sheets, either for tinning or "galvanising." The object aimed at is usually to recover both the iron and the acid, and there is of course no difficulty in doing this—the only difficulty is to make it pay. We shall be glad to be assured that the problem has at length received a successful solution.

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LIGHTNING CONDUCTORS.—IX.

BY DR. OLIVER LODGE.

(*Continued from page 165.*)

Alternative Path Experiments in September, 1888—(*Continued*).

September 26, 1888.—I now arranged a new set of wires round the room, making them all the same length, and each enclosing a rectangle 475 × 875 square centimetres. The wires were of iron, copper, and lead respectively, a thick and thin wire of each. The length of each wire was 2,686 centimetres. The following are the particulars:—

Description of Wire.	Thickness.	Common Resistance.	Self-Induction.
	Millims.	Ohms.	Centimetres.
No. 12 Iron.....	2·40	·73	44,820
No. 27 „	·40	22·6	54,540
No. 12 Copper	2·35	·31	44,820
No. 27 „	·40	4·1	54,540
No. 11 Lead	2·90	·93	44,820
No. 23 „	·70	13·7	52,000

These wires were to be used as alternative paths, and the rest of the circuit was to be varied as seemed good. The object of this series of experiments was to examine more closely into the question of iron *versus* copper, to see whether the apparently anomalous result of iron wire affording a better alternative path than thick copper could be definitely repeated, and to determine the conditions under which the result occurred. At Bath I had promised to go into this matter more carefully, and at this time I had not worked out at all fully the theory of the alternative path experiments, so that I was in the dark as to the conditions under which the apparently anomalous result was to be expected.

The gallon jars already specified were employed. The A knobs were those of the universal discharger already described, and the machine was joined up to them with the intervention of pieces of wood pretty much as in Fig. 9, p. 164. The B knobs belonged to the spark micrometer.

The A spark length was 2·44 centimetres; its light not screened off the B knobs. The B knobs were adjusted till about half the sparks passed and half failed. The alternative paths were joined up to the B knobs by pieces of wire, each 122 centimetres long; at first of No. 12 copper.

Details of Circuit.	Length of B Spark with different Alternative Paths.			
	No. 12 Copper.	No. 12 Iron.	No. 27 Copper.	No. 27 Iron.
A knobs connected direct to jars	1·60	1·65	1·64	1·67
A knobs connected to jars by means of a couple of lengths of No. 17 copper wire, each 230 centimetres long and 0·15 centimetres thick, opened out to form a rough circle.....	1·88 1·83	1·87 1·83	1·77	1·745
Same, but with a couple of No. 27 iron wires used to join up the alternative paths to the B knobs (each wire 122 centimetres long) instead of the No. 12 copper pieces	1·76	1·74	1·76	1·79
Same, but with relative position of jars and connecting wires in the A part of the circuit interchanged.....	1·575	1·575	1·61	1·62
Long wires between jars and A knobs removed.....	1·535	1·535	1·57	1·62

Thus, then, under these circumstances, iron showed often some slight disadvantage as compared with copper, only in one case showing an advantage, and that not great. But it was noticed that the noise of the A spark was always distinctly enfeebled when the thin iron wire was in circuit.

The object of interposing different conductors between the B knobs and the main length of alternative path was to see if the first portion of this path had an exaggerated influence on the result. Hence the use first of No. 12 copper leads and then of No. 27 iron. No such exaggerated influence of the first portion was detected, however, nor is it now pointed to by theory.

I see no clear reason why introducing longish wires into the A part of the circuit should in one case lengthen the B spark and in the other case shorten it. The only obvious difference between the two cases is that in one case the wires were charged, forming part of the inner coats of the jar, while in the other case they formed part of the outer coats and were uncharged. The *de*crease they cause is natural (extra self-induction), but the only obvious reason for the *in*crease is their static capacity, which one would not suppose sufficient to make so much difference.

September 27.—Next day the gallon jars, standing ordinarily on a table, were connected direct to the knobs of the machine, these knobs being used as A spark (as in Fig. 5, Article I.), and the outer coats of the jars were connected to the alternative paths round the room by a yard or two of No. 18 copper wire. Length of A spark being about 3·52 centimetres, the following are the B spark readings when balanced against different alternative paths:—

Alt. Path.	B Spark.
No. 12 copper	The greatest length of B spark attainable was 4·15; it then nearly always failed. At 3·1 it nearly always passed. Sometimes it could be screwed up to the maximum without failing, and then, once it failed, it had to be screwed down to 3·6 or so before itcould go again.
No. 12 iron	3·1 or thereabouts. It fails mostly even at 2·9.
Thick copper again.	Went up to 3·4 or so.
No. 27 iron	At 2·65 it was half and half. At 2·8 it generally failed.
Thick copper again.	Generally passed at 2·85, nearly always at 2·8.
Thin iron again ...	Always failed at 2·8.

To compare these two leads more particularly, a couple of switches or bridges were employed, one of which switched in the thick copper lead, the other the thin iron; and it was clearly perceived many times that the B spark was both longer and stronger with the thick copper alternative path than with the thin iron. With the thin iron path it failed more frequently at a set distance between the B knobs, and when it occurred it sounded weaker, "showing distinctly that iron *does* cause a shorter and weaker spark than copper; but why? It must be the surgings in the conductor one is observing, and they are weaker in the iron." This is a quotation from my notebook at the time, and shows that the true explanation, subsequently confirmed by theory, was first suggested by experiment.

Experiments in Answer to Criticism.

September 28.—At Bath, Prof. Forbes questioned my mode of connecting up the alternative path to the outside of the jars, and though the objection does not bear critical examination, it was worth trying what difference there would be if the long wire were charged instead of remaining at zero potential. Accordingly the connections of Fig. 4, in the first of this series of Papers, was adopted. The A spark being set at 1·89, the following were the B spark lengths when balanced against the stated alternative paths, and just failing:—

No. 12 Copper round room	1·60
No. 27 Iron „ „	1·63
No. 27 Copper „ „	1·61

Practically all the same, but a trifle longest with the iron. To be sure that the wire was acting conductively, and not merely by static capacity, it was cut in the middle of its length, *i.e.*, at the far end of the room, and a six-inch length of silk thread interposed. The B spark length was now 3·5, everything else remaining the same. At the break in the wire long sparks could be got to discharging tongs, &c., and there was a slight noise or click at the cut gap at every failure of a B spark, a noise noticed by an observer standing near the gap before the sound of the A spark was audible across the room.

Experiments on Effect of Surrounding Medium.

At Bath, Mr. Preece suggested that the nature of the medium surrounding the wire would probably have an important influence in these alternative path experiments; and although I saw no reason for the supposition it seemed quite possible, so

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to test it the following experiments were made at beginning of October, 1888 :—

A couple of pieces of wood, 17½in. by 16in. by ⅞in. thick, were edged with thin wooden flanges or projections, so that when wound with wire the wire would have a half-inch clear space between it and the wood. A length of 302in. of No. 12 copper wire was then wound on each frame in 8 coils, each coil having 2in. between it and the next, the pair of frames being wound exactly alike.

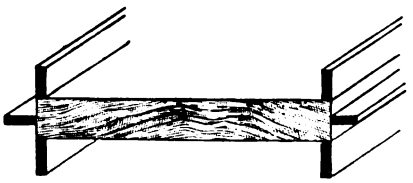

FIG. 10.—End of Wooden Frame for Coil.

Their equality was then tested by using them as alternative paths. The following are the B spark lengths (length of A spark, 1·51 centimetres) :—

——	No. 1 coil.	No. 2 coil.	No. alternative path.
Length of B spark, using pint jars	·928 ·928	·928 ·928	1·346
Using gallon jars	1·040 1·034	1·045 1·043	1.505

They are practically exactly equal.

No. 2 was now immersed in melted paraffin, in such a way that when solid it should be completely embedded in a cake of solid paraffin, 1in. thick above the wire everywhere.

They were then tested again.

		No. 1 coil.	No 2 (paraffined) coil.
Pint jars	A spark 2·0	1·054	1·074
	„ 1·5	·917	·906
	„ 2·5	1·25	1·25
Gallon jars	„ 1·5	1·03	1·03
	„ 2·0	1·26	1·26

Their equality is, as far as one can tell, absolutely undisturbed. The change of surrounding medium from air to paraffin makes no appreciable difference.

To see if a *conducting* covering would have much effect, the paraffined coil (which looked like a solid block of paraffin) was now coated all over with tinfoil, except just at the places where the terminals protruded. The following were now the B spark-lengths :—

——	No. 1 or uncovered coil.	No. 2 coil with tinfoil insulated.	No. 2 coil with tinfoil earthed.	No. 2 with tinfoil to one of the jars.
A spark 1·5	·906	·841	·828	...
A spark 2·0	1·048	·886	1·026	·884
A spark 2·5	1·258	1·104	1·098	...
Covered No. 2 up now in soldered tinplate, in addition to the tinfoil, except for the terminals.				
A spark 1·5	·860	·775	·775	...
A spark 2·0	1·068	·933	·935	...

Thus in this case there is a distinct though not very great diminution of the B spark caused by the surrounding metal, whether it be earthed or not. The armour-plated coil makes a *better* alternative path than the bare wire, a result which is natural enough.

(To be continued.)

Specific Resistance of Sulphur.—On page 254 of our last issue, the specific resistance of sulphur at 440° C. and at 350°C. is given as 7 7 and 56 5 megohms respectively; it should be 7·7 and 56·5.

THE PARIS EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT).

July 15, 1889.

One of the most creditable of the English exhibits is that of Messrs. Paterson and Cooper, who show a variety of electrical measuring instruments and appliances, amongst which are included the well-known permanent magnet ammeters and voltmeters of Ayrton and Perry, which this firm has manufactured since their first appearance. Messrs. Paterson and Cooper's ammeters and voltmeters constructed on the electromagnet principle are also shown. In these instruments, for the weak controlling force of an electro-magnet is substituted the powerful force of a spiral spring. In the case of ammeters, for currents of ordinary intensity the electro-magnet is wound with wire in the usual way, but for the measurement of large currents the wire is replaced by a single bar of copper 1½in. diameter, the magnet being in the form of a ring which nearly embraces the bar, leaving only a sufficient space between its open ends for the soft iron deflecting needle to lie in. (See *The Electrician*, December 7, p. 35, 1888.) Several Cardew voltmeters of the latest design are shown, as well as a Pocket Voltmeter about the size of an old-fashioned watch. A Thomson and Starling Universal Photometer for measuring candle-powers from half a candle to 10,000 candles, is also exhibited. In addition to these useful instruments, Messrs. Paterson and Cooper have an interesting collection of fittings and accessories connected with electric lighting. Amongst these, a polished slate tablet for a six-circuit distribution, on which are mounted the necessary switches, fuses and measuring instruments, is conspicuous.

Amongst the many excellent exhibits of Swiss electrical engineering firms that of MM. Cuénod, Sautter et Cie., of Geneva, is very prominent. This firm show several types of the Thury dynamo, Thury automatic current regulator, and Thury arc lamp. The Thury dynamo is a six-pole machine, with very small internal resistance, and running at a low speed. The table below gives some data respecting the speeds and outputs of these machines :—

Horse-power absorbed.	Power in Watts.	Revolutions per minute.	Weight in lbs.	Watts per lb.
41	27,500	450	4,400	6·2
57	38,500	450	5,500	7·0
81	55,000	450	6,600	8·3
81	55,000	250	9,900	5·5
115	77,000	350	9,900	7·7
185	125,000	185	13,200	9·5

The Thury Automatic Regulator can be used for constant-potential purposes, although it is generally employed to regulate the current of dynamos driven at varying speeds, and for other similar purposes. The apparatus is made of two types; in one, the necessary motive power is obtained either from the dynamo pulley or independently, in the other an electric motor is provided. In the first type the regulation of the current is effected by the switching in or out of resistances, the rheostat being provided with a large number of contacts to avoid sudden alterations in the current strength; in addition to which, the contact-switch is divided into two pieces insulated from one another, but connected through a resistance equal to the mean resistance between any pair of contacts, which device still further conduces to smooth working. The switch is carried on a horizontal axis, actuated by a wheel and tangential screw; this screw is itself actuated by two friction cones driven by means of cords, an arrangement which is strikingly similar to that found in Prof. Jamieson's Electric Governor. The friction cone shaft is capable of a longitudinal movement when the soft-iron disc at its extremity is attracted by the electro-magnets. When the disc is pulled towards the right-hand magnet, the movement of the shaft brings the left-hand cone into contact with a large friction wheel on the shaft of the tangential screw, thus causing a movement of the rheostat switch. If the left-hand electro-magnet is energised, the rheostat switch is in a similar manner moved in the reverse direction. The

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magnets are brought into play by means of a solenoid, the core of which is connected to a small lever, which switches one or the other of the magnets into circuit as required. The terminals of the magnet coils are themselves carried on a movable lever, which is connected with the rheostat switch in such a manner that whenever it moves it immediately breaks the circuit of the magnet coils. By this device, over-regulation is guarded against, for when the current increases and the core of the solenoid brings one of the electro-magnets into play by moving the lever, the resulting movement of the rheostat switch immediately breaks the magnet coil circuit, which is only re-established should the current continue to increase. In practice this regulator proves very sensitive and quick in its action.

In the second type of regulator the current alone supplies the necessary motive-power. The two electro-magnets are dispensed with, and the lever of the solenoid reverses the direction of rotation of the motor.

Regulators of this description have been adopted to maintain a constant difference of potential at the terminals of the lamps in the Geneva Theatre. The current for this installation is obtained from the central station, and as the demand for current varies enormously it was found absolutely necessary to compensate for the losses in the leads by means of automatic regulators of the second type.

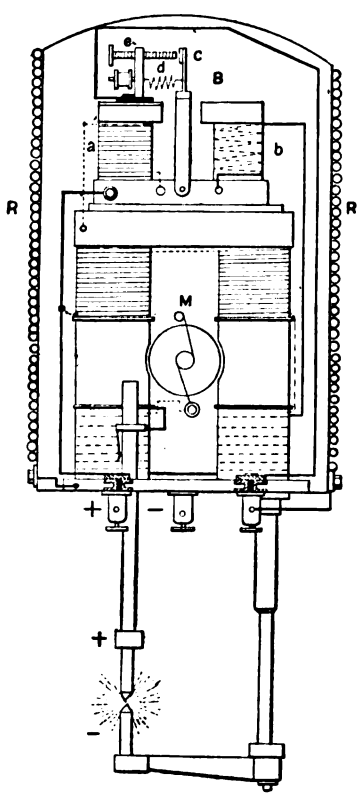

Fig. 1.

The Thury Arc Lamp (Fig. 1) is of the self-focussing motor type, and is, as a rule, wound differentially. The lamps are constructed to burn continuously for 14 hours and are provided with a by-path, B, containing a resistance, R, approximately equal to the normal working resistance of the lamp. In some cases the series coil is done away with, and the action of the shunt coil is strongly reinforced; the lamp can then be made to work on almost any circuit, provided, of course, that the size of the carbons is adapted to the particular strength of current employed. The motion of the carbons is caused by two motors, one an electric motor, M, the armature and magnets of which are a shunt to the arc, the other motor consisting simply of the lower carbon-holder and a counterpoise. The former brings about the approach of the carbons, the latter draws them apart. In the differential type, the lower portion of the magnets has a series winding, acting in opposition to the shunt coils. To prevent the carbons coming together too rapidly the armature of the motor is completely enclosed in a copper case so that racing is immediately checked by the generation of powerful Foucault currents. The two carbon-holders are mechanically connected by means of a series of toothed wheels, arranged so that the descent of the negative carbon causes the ascent of the positive carbon. The motor actuates the carbons by means of a large toothed wheel, and as the field magnets are chiefly energised by the shunt coils, it only acts when the carbons are apart, and the further they are apart the more powerful its action. In the differential lamps, of course, the motor only acts when action of the shunt coils overpowers that of the series coils. The by-path B consists of an electro-magnet, *a*, *b*, between the poles of which oscillates the armature *c*. The limb *a* is excited by the shunt-current, and the limb *b* by the main-current. A spiral spring, *d*, keeps the armature *c* against the screw-contact *e*, which is in communication with the resistance coils R, which are wound round the exterior of the lamp and connected to the negative terminal. At the moment when the current is started, the carbons are apart, the shunt coil *a*, therefore, acts with great effect, and keeps the armature *c* firmly against *e*, and the motor soon brings the carbons into contact. At this moment the series coil *b* of the by-path is traversed by a strong current, and the shunt coil *a* is deprived of current; the result being that the armature *c* is pulled away from *e*, breaking the by-path circuit. The lamp then works in the normal fashion. Whenever the difference of potential at the lamp terminals becomes dangerously high, the shunt coil *a* attracts the armature *c* and cuts the lamp out of circuit. The working of this lamp is said to be very satisfactory.

A good show is also made by another Swiss firm, Messrs. Brown and Co., of the Oerlikon Engineering Works, near Zürich, who exhibit a large number of dynamos for public lighting, ship lighting, and transmission of power purposes, together with arc lamps, switch-boards, and other accessories. This firm also have on their stand in the Palais des Machines several steam engines which have been specially designed for dynamo work. One of the most prominent exhibits is a 200 horse-power transmission of power plant. The generator and motor are of the usual Oerlikon type, with 4 poles, cylinder armature, and cast-iron field-magnets set radially, their outer extremities being connected by a very massive yoke, the lower half of which is cast in one with the bed-plate. The two machines are precisely similar, except that in winding the armature of the motor allowance has been made for the volts lost between it and the generator, in order that both machines may run at approximately the same speed. The armature of the generator is wound with 400 turns of 19 strand 1·3 millimetre copper cable, while that of the motor has only 368 turns. The commutator, which like every part of these machines is of most substantial construction, has 200 segments in the case of the generator and 184 in the case of the motor. The armature core in built up in the usual way of soft sheet-iron discs, 6 millimetres thick, separated by paper. The field-magnets are wound with copper sheet 1 millimetre thick and 300 millimetres wide, each limb being wound with 60 turns, and all four windings being in series with the armature. When running at 500 revolutions the generator has an output of 625 volts and 270 amperes (168 kilowatts), though these figures may safely be exceeded if necessary. The motor of the transmission plant drives the main shafting in the Swiss Section in the Palais des Machines. These dynamos, I may mention, are of the same type as those now at work at Schio (Italy) and Derendingen (Switzerland). The same firm also show a small transmission plant. The machines in this case are of the two-pole type, and the motor drives the shafting of the Swiss Section in the gallery. In addition they exhibit two steam engines, with dynamos coupled direct. One of these dynamos is a four-pole machine, with a series-wound drum armature and an output of 65 volts and 180 amperes. This particular type of dynamo is intended more especially for use on board ship, and is, therefore, what is commonly known as "ironclad," and has little or no external field. The other dynamo is a two-pole machine, with an output of 65 volts and 500 amperes, and is used to supply current to twenty-eight 8-ampere arc lamps lighting a part of the Swiss Section. These lamps, which are of remarkably simply design, I shall refer to later on.

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The steam engines exhibited by the Oerlikon Engineering Works in connection with their dynamos are all of the vertical type, and comprise a 200 horse-power compound condensing engine, running at 180 revolutions and driving the generator of the transmission of power plant through belting; a 50 horse-power engine of similar type, running at 360 revolutions, and coupled to the arc-light dynamo, and a small single-cylinder engine, which runs at 480 revolutions, and drives the ironclad dynamo.

The chief feature of the Brown arc lamp is its great simplicity. In the generality of lamps the violent jerks caused by sudden variations in the resistance of the arc are modified by ingenious but complicated regulating devices. Mr. C. E. L. Brown has, however, dispensed with all regulating gear. It will probably be remembered by your readers that about this time last year, in a short note to *l'Electricien* (see *The Electrician*, August 10, 1888, p. 446), M. Hospitalier pointed out as a matter of common knowledge that arc lamps run off constant potential circuits regulate better the greater the distance in the

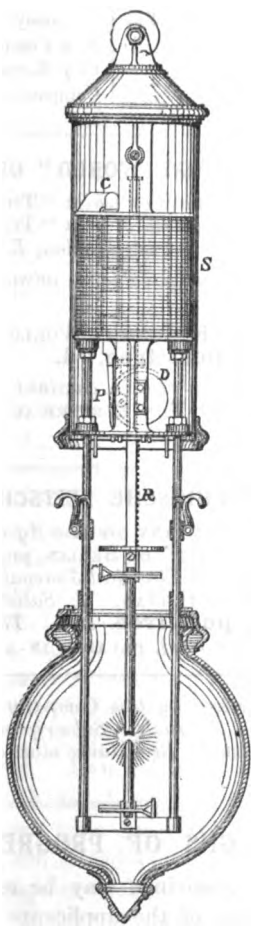

FIG. 2.

branch, and suggested that if we could use an electro-dynamometer (whose action is proportional to the square of the current) in lieu of an electro-magnet, we should increase the sensibility of the arrangement, and should be able to work satisfactorily with about 60 volts, instead of 80 or 100 at the dynamo terminals, and dispense with wasteful intercalated resistances. Mr. Brown has not indeed adopted the particular device suggested by M. Hospitalier, but he has nevertheless produced a lamp which works remarkably smoothly on a constant-potential circuit, without any intercalated resistance whatever, and with less than 50 volts at its terminals. In the Brown lamp the lower carbon is fixed, the upper carbon hanging from a rack, R (Fig. 2), gearing with a small pinion. On either side of this pinion, and upon the same axis, are two large, soft iron discs, D. Above these is the large solenoid S, and inside this is the iron core C, suspended from a spring, and capable of moving both vertically and laterally inside a brass cylinder, which forms an air dash-pot. The lower part, P, of the core is flattened out, and is a millimetre or two away from the rims of the iron discs. Between the face of the pole-shoe and the edges of the discs a thin layer of brass is interposed, which becomes thicker as it goes higher up the iron. The action of the lamp is as follows:—When the current passes, the core becomes magnetised and is simultaneously attracted upwards and against the iron discs, which consequently turn round and strike the arc. As the arc becomes longer the core slowly descends, and the carbons approach one another. At the same time the magnetism diminishes, and when the core has reached its middle position the smaller attractive power, acting through a greater thickness of brass, allows the discs to slip round slightly. In practice the working position of the core remains the same, and all feeding takes place by this slipping action. These lamps, as I have remarked above, are employed to light a part of the Swiss Section, so that their satisfactory working can be seen by any one visiting the Exhibition.

In addition to measuring instruments, the Oerlikon firm show an automatic safety apparatus, which short-circuits the magnet coils of a dynamo in case of dangerous excess of current. This automatic apparatus consists of a straight electro-magnet, having a long core. Beneath this core is an armature working on a hinge, and which in its position of rest holds up the end of a weighted lever, the lower extremity of which turns on an axle held in a frame. Beneath this lever are two parallel spring contacts, and as soon as the current attains a strength of about 20 per cent. above the normal, the armature is drawn upwards, the lever is released and falls between the two springs, short-circuiting the field-magnet coils. This device is fitted to the generator of the large transmission plant, while at both ends of the line there is a switch by which the circuit can be broken gradually whenever the necessity arises. In this switch the metallic contacts are broken first and the arc is then drawn out from a carbon contact, the arc being slowly lengthened until the breaking point is reached.

The exhibits of these two Swiss firms are of a very excellent order and do credit both to their enterprise and engineering capacity.

The huge ball given last week at the Palais de l'Industrie was the occasion of a very complete installation of the electric light. The methods employed to light the building were somewhat diverse. Two 300-light Edison dynamos connected in series, and regulated to give about 300 volts, supplied 250 Henrion or Pieper arc lamps arranged five in series. Across the dynamo terminals were placed three batteries each of 150 Philippart accumulators with a view of lightening the work of the machines. The larger part of the incandescent lamps were supplied by two 1,000 light Edison dynamos, but 1,600 lamps were run off transformers, the primaries of which were connected to the main running from the Edison station at the Palais Royal to the Élysée.

The jury for Class 62 (electricity) has at last been finally constituted. The president is M. Mascart; the vice-president, Mr. Preece; the reporter, M. Potier; and the secretary, M. Turettini. The jury is divided into four sections, as follows:—1st section: Dynamos, transformers, and measuring instruments—MM. Fribourg, Hering, Potier, Sciama, Turrettini. 2nd section: Telegraphy, telephony, electric signalling apparatus, cables, wires—MM. Aylmer, Marcel Deprez, Jousselin, Preece, Trottin. 3rd section: Electric lighting apparatus—M.M. Huet, Postel-Vinay, Rau, Rousseau, Sautter. 4th section: Electrochemistry, batteries, accumulators, bells, miscellaneous appliances—MM. Abdank, H. Fontaine, Gody, Mascart, Sebert. The jury will meet at 27, Avenue de Labourdonnais, and the different sections at the offices of Class 62.

The fact that there have been three slight fires in the Exhibition due to the electric light leads shows very clearly that the wiring is not what it ought to be, and it would certainly seem advisable to look more carefully to the insulation, if occurrences of this regretable character are in future to be avoided. The first two fires, which took place in the garden facing the Palais des Arts Libéraux and in the Palais des Machines respectively, were instantly extinguished. The third fire, which happened in the conduits running between the Palais des Machines and the Galeries des Industries Diverses, was not put out under half an hour.

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The Electrician.

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SIGNS OF PROGRESS.

Although some misgivings may be reasonably entertained with regard to certain of the applicants who have joined the crowd of new Electric Lighting Companies now seeking Provisional Orders at the hands of the Board of Trade, the general effect is encouraging to the trade and reassuring to the public. Special interest, however, at this moment attaches to the established companies whose business prospects, based on actual experience, will afford some indications of what the new Undertakers have to expect. It happens that Reports relating to at least three well-known companies have just been issued, and that the contents afford information of a kind which at this juncture is much needed. Last in point of date, though not in importance, is the EDISON AND SWAN COMPANY'S annual report to be presented at the general meeting of shareholders on the 30th inst. They are to be congratulated on several grounds, for they have not only emerged victorious out of a series of legal conflicts, but have earned a handsome dividend which they are now in a position to distribute. This dividend, which is 7 per cent. on the A shares for the year ended 30th June, 1889, and 3 per cent

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on account of arrears of preferential dividend in respect to the same period ended 1884, was anticipated at the last November meeting, but was held over because of the uncertainty which then prevailed as to the result of the appeal in the action against the Brush Company. Happily the threatened reference to the House of Lords has been abandoned by that Company, and an understanding arrived at which leaves the Edison Company in undisputed possession of their lamp patent, the taxed costs of the action being paid by the Brush Company. This result sets free the earnings of the successful litigant; and that they amount to a sum which enables such a dividend as we have named to be paid out of them is evidence of the soundness of the business in which the Edison Company is engaged. That business is now exclusively confined to the manufacture of lamps, fittings, and electrical apparatus; and although we may regret that the course of events has created a monopoly of lamp industry for the Edison Company, the fact that, notwithstanding the prices they are able to charge, their sales continue at an enormous and progressive rate is a further proof of the strides which electric lighting is making.

The ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION is the second of the companies on whose affairs we are able to comment, a report of its directors to be presented at an extraordinary general meeting to be held next Monday being now in our hands. Freeing itself from the costly proceedings referred to above, the Brush Company is about to make a new departure in view of its rapidly growing business and the demands that will be made upon it when the impending schemes for electric lighting throughout London and the provinces get fairly to work. It is stated that already the orders for the past half-year exceed those for the whole of the preceding year, which were considerably greater than for the year previous, and the directors have reasonable grounds for believing that the next half-year will be still more prosperous. This being the case, and the existing manufacturing premises being already far too small, a large addition to the Company's powers of production has been obtained by the acquisition of the "Falcon" Works at Loughborough, in Leicestershire, where the old engineering business will be carried on, in addition to the new electrical business which is to be brought into it.

In still another direction this Company has made a fresh move which will not unlikely be imitated by other companies similarly situated. A subsidiary company was formed in 1882 to work the Brush and Lane-Fox patents in the Australasian Colonies, and has acquired a peculiarly strong position both in those latitudes and in India and South Africa; but the operations of the Company itself as well as of the parent company have been hampered by the undertakings entered into between them; and it is now seen that an amalgamation will be advantageous to both. This it is proposed to effect, and the necessary readjustment of capital consequent upon the amalgamation and the "Falcon" purchase scheme will be submitted for the approval of the Anglo-American Brush Company's shareholders at the forthcoming meeting. A call of £1 per share will be made in respect of the 25,511 £5 shares on which only £4 has yet been paid up; but with this exception no fresh strain will be put upon the shareholders, the purchase and amalgamation projects being arranged on the basis of payment in shares of the new Company to be created by the union of the three. The ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION will, it is proposed, be known in future as the BRUSH ELECTRICAL ENGINEERING COMPANY, a change of title which we think will be more in accordance with facts, as well as more agreeable to the Company's customers.

Of the LONDON ELECTRIC SUPPLY CORPORATION, whose report, which is represented by a well-drawn-up balance-sheet, was presented at the meeting on Monday last, we need say very little. A full account of the proceedings is published in our present issue, and it will be seen that the outlook for this Company is not less promising than that of the companies already referred to. The history of the undertaking, however, is different, and perhaps more instructive. The other two are manufacturing companies, whereas this is an electrical supply company. Known for some time briefly as the Grosvenor Company, it was worked as a private or semi-private affair, and, it is confidently asserted, at very considerable profit to the proprietors. When the schemes for lighting the metropolis begun to take shape naturally this highly-successful company was coveted as a nucleus for one of the most profitable businesses to be absorbed; but eventually the Grosvenor Company became the LONDON ELECTRIC SUPPLY CORPORATION, with its extensive works at Deptford, the Grosvenor's plant keeping the business going until the new works are sufficiently matured to do the whole business. Even as matters stand, the accounts of the Corporation show a small balance on the right side; and the areas assigned to it, we need hardly say, are some of the best in the Metropolis. Its balance-sheet is a model of clearness, and is calculated to inspire confidence in the minds of the shareholders, as well as of the general public who examine such documents emanating from electric lighting companies with a suspicion perhaps not wholly undeserved. Altogether a review of the position of the three companies here commented upon will satisfy any impartial observer that the electric light has made and is making progress at a rate with which we have every reason to be satisfied.

AN ELEMENTARY ANALYSIS OF THE GENERATION OF CURRENT AND POTENTIAL DIFFERENCE IN DRUM ARMATURE WINDING.

BY F. M. WEYMOUTH.

Events frequently march with a rapidity that all are not able to keep up with. Hence there are those who sometimes find themselves behind the times. This is especially the case with inventions of all kinds. It is not possible to follow up closely the periodical growth of many inventions, and to keep well abreast with the theory that may be involved in them. And all this applies not less to the growth and development of electrical science and machinery than in any other direction—in fact, we might say it especially applies to electrical matters. Thus, regarding the subject in this light, and in view of the fact that since the lapse of the Siemens' patent for drum winding this form of winding has come largely into use, it has appeared to us that it might be of interest to many if we were to conduct a species of investigation into this form of winding, having particular regard to the manner in which the current and potential difference are generated and the torque set up.

It may be well, however, first to consider briefly what are the more essential advantages that this method of laying the conductors on an armature possesses over the Gramme winding it is now to so great an extent superseding. Some of these are more or less obvious. It offers the whole area within the limits of the periphery and ends of the drum for the passage of lines of magnetic induction, as compared with the portion only of this total area offered by the Gramme ring type. Hence, other things being equal, for any given length and diameter of core, the drum will give the larger output; and conversely, for any given output, the drum armature, and with it the whole machine, can be made smaller, and so cost less than the other type. A greater radial depth of iron also can be got into the core, still further favouring the passage of lines of magnetic induction—a point of great moment. Economy in copper is also promoted, inasmuch as there is less length of conductor, as compared with

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the Gramme type, owing to the absence of the interior parallel conductors that exist with the latter. This consideration is, however, much affected by design, a question it is not our present object to discuss.

The accompanying diagrammatic sketch represents in isometric perspective the drum-winding of an armature with commutator, but without spindle or core, except that the last-named is indicated by two lightly-dotted circles. A winding of eight turns only is depicted, so that all parts may be visible, and the commutator is shown an abnormal distance from the core to avoid the complication of its covering the cross-connections behind it. This sketch represents in essence what is the more modern method of arranging the windings, particularly for heavy currents. In the earlier drum armatures, such as those of Siemens and Edison, it was the custom to connect up the different sections, not one after the other, in order round the periphery of the core, but variously. This disorder of connection had the effect of preventing the attainment of a minimum difference of potential between neighbouring commutator segments, so that sparking at the brushes was not diminished as much as might be. But for constructional reasons also it is now more customary to effect the joining up, as here shown, one section after another in regular order round the armature. To assist the eye in following up the connections, the parallel

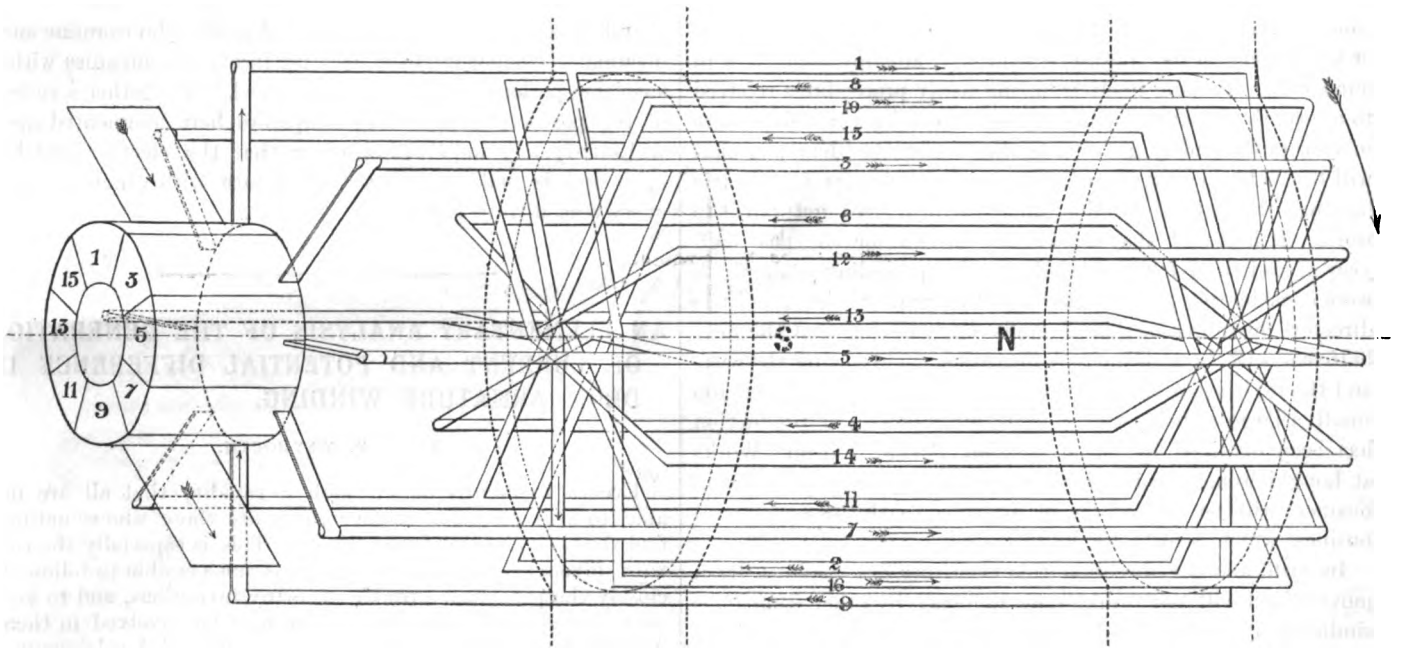

Diagram of a Drum Armature Winding.

conductor-bars are here numbered in the order of their connection. No. 1, for instance, is joined at the right-hand end to No. 2, and No. 2 at the commutator end to No. 3, and so on till No. 16 is united at the commutator end to No. 1 again. The bars with odd numbers alone, it will be observed, are extended to the commutator lugs. Each odd-numbered bar, and an even-numbered bar nearly opposite, with their end connections, form a section of one turn, the end of each section being joined up behind the commutator to the neighbouring odd-numbered bar, and not to its own. An endless circuit is thus formed round the armature, connected up at eight different points, corresponding to the eight sections, to eight several insulated commutator segments. Sometimes two turns per section are put in; only this, with conductors for heavy currents involves a double series of end connections, which, according to design, may add considerably to the total length of the armature and increase the percentage of inactive copper—that is, of copper not actually cutting lines of induction, and producing electromotive force. This latter reflection, indeed, bears on all copper projecting at either end beyond the core, which is, of course, confined within the limits of the length of the shorter even-numbered parallel bars. For many turns per section of wire for small currents it may be necessary to resort to the old Siemens' method of wrapping round the ends, or to modifications of other arrangements.

The armature in our illustration is represented as revolving in the field between two pole-pieces, shown by the heavy dotted lines, the back one of which is south and the front north, as indicated by the large S and N, and turning in the direction of the curved arrow. The lines of force, or magnetic induction, will, therefore, be going from the front towards the back, though with a normal distribution more dense toward the top and bottom, where the poles are closer, than in the middle. This latter inequality, however, is of course much modified by the iron of the core. Each section of the winding will form a loop or circuit revolving in this field, and when in a vertical position, such as section 1—16 nearly occupies, will enclose a maximum number of lines, as compared with none at all when lying horizontal. Revolving in this field, an electro-motive force will be generated in the conductors.

Firstly, now to consider the direction of the current, weknow that according to the law discovered by Faraday, when a circuit revolves in a field such as here represented, the direction of the current will depend on two things, namely, according to which side of the loop the induction lines enter, and as to whether, during the revolution, the number of these lines is increasing or diminishing. If the loop revolves so that when the lines are diminishing in number they enter on the side towards which the top bar approaches, then, as viewed from this side, the current will run from left to right in the top bar, and round again from right to left in the lower bar. This is the condition in our illustration, where the point of view, N, is at the front. Now, it is obvious that during one revolution there are four different times when the conditions change. The circle of the revolution of the armature may be divided into four quadrants, defined approximately by the vertical and horizontal centre lines. The four times of change are thus those instants in which any bar of a section passes successively from each of these quadrants to the next. There is a difference, however, between the conditions at two of these instants as compared with the other two. When a given bar at the top passes from a quadrant on one side of the vertical to that on the other side and back again at the bottom, only one change takes place at each of these two instants, namely, that the enclosed lines of force that were increasing in number as the bar approached the top (or bottom) will now be decreasing in number. But at the two instants when the loop is about horizontal and one given bar passes from an upper quadrant to the one below and rises again on the other side, *two* changes take place at each of these in-

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stants. Firstly, the number of induction lines that were decreasing in number to zero will now commence to increase again; and secondly, whereas the lines had been entering the loop on the one side, they will now commence to enter on the *other* side. It hence arises that when passing the vertical position, where there is only one change of condition, this change reverses the direction of the current round the section. But when passing the horizontal position the one change from excluding to including lines of induction is simultaneously cancelled by these lines commencing to enter on the other side of the loop; hence the current is not reversed at these latter two instants. The aggregate result, therefore, is that the current is reversed only as each section passes the vertical (approximately), and is always running from right to left on one side of the armature and from left to right on the other side. Thus, in our sketch, the direction of the current is to the right in front and to the left at the back, as indicated by small arrows, while those sections which are nearly vertical, namely, 1—16 and 9—8, are neutral. This approximately vertical plane is, of course, what is known as the plane of commutation, though we shall refer to this again further on.

We have dealt so far with the direction of the current merely. We have now, however, to consider the rise of the "electromotive force," or "E.M.F.," or "potential," as it is variously termed, and without which there would be no current. This, as is well known, is proportionate to the maximum number of lines of force passing through the section, or loop, and the speed of the revolutions. The field may be small and intense, or large and weak. Regarded more intimately as to the speed, the potential varies according to the *rate* at which the magnetic lines are included or excluded by the section. Now, as in the case before us, when these lines run horizontally, it is palpable that when the section is about vertical, the *rate* at which it is including or excluding lines is scarcely more than nominal, as the revolution through a small arc at the top or bottom makes little difference in this respect. Hence the E.M.F. generated here passes through zero value. When nearly or about horizontal, the reverse hold good, as the section is in the most advantageous position for this purpose, and excludes and includes the lines as it respectively approaches and leaves the horizontal at its maximum *rate*. Hence the maximum E.M.F. is gathered when the sections are about horizontal; but potential is also being generated in the intermediate sections between the horizontal and vertical. Theoretically, the E.M.F. generated in any one of these varies not with the angle but with the sine of the angle which its plane makes with the vertical plane; or, in other words, varies directly with the horizontal distance of its bars from the central vertical plane, similarly as the number of lines of induction enclosed varies with the vertical distance of the bars from the horizontal plane. It must be clearly understood that the foregoing refers only to the *generation* of the potential in each several section, as the potential difference that may actually exist in any section at any instant may be very different from that which it is itself at that instant generating. We may now consider the course of the current round the winding, together with its accumulation of E.M.F., and its delivery to and return from the outer circuit. Referring to our sketch once more, it will be observed that the brushes touch on the segments of the commutator connected to bars 1 and 9. To commence with bar No. 1, we immediately remark that this being in connection with the upper brush, and the current in it running from left to right, the current from the outer circuit will here be entering, and the upper brush will be the negative brush of the machine. In this bar 1 there will be the minimum potential difference, and from its approximately vertical position it can generate practically none. The current running to the right passes across the end to bar 2, thence to the left and across again to bar 3, accumulating E.M.F., and so through sections 4—5, 5—6, where it practically gets its greatest amount of E.M.F., through 7—8, and to the left-hand end of bar 9. This latter being connected to the segment whereon the lower brush makes contact, the current will here pass to the outer circuit, and this brush will form the positive pole of the machine. But the total current and potential difference here, it will be observed, are what has been accumulated in the sections represented by bars 3, 5, and 7 only; and these form but half the winding, not counting neutral sections. We have now to account for the other half. Returning to bar 1 again, this, with bar 16, forms a section about vertical, and consequently neutral. The right-hand end of this latter bar (16), however, is connected across to bar 15 on the further side, where the current is in all cases running from right to left. Hence, whereas one half of the incoming current passed along the length of bar 1 and so to bar 2, the other half will cross to bar 16 at the commutator end, and thence into the series of sections 15—14, 13—12, 11—10, gathering potential difference on its way, on to the right-hand end of bar 9, and so to the lower brush, together with the current entering that bar at its left-hand end. Thus the current, entering at the left end of bar 1, has two paths in parallel which it may follow throughout the two series of sections which alternate with one another round the armature to reach the positive brush; but the potential accumulated in each of these series is the same. Hence, as when two pipes of similar diameter delivering water at the same head (or pressure) unite in one common pipe, the pressure may remain the same, but does not increase, while the amount of water delivered, or the current, is doubled, so the current delivered at the lower brush is equal to the currents of both series of sections added together, or twice that of one of them, while the electromotive force is not doubled, but remains only such as is accumulated in either one of the series. Hence, in calculating out a drum winding it is requisite to obtain the total area enclosed by the several sections of one series only to ascertain the electromotive force, while the section of the bars need be only half that necessary to carry the whole current of the machine. It will be observed here, in accordance with a remark we have already made, how that although there will be little or no potential difference *generated* in sections 9—8, 9—10, yet the potential difference actually existing in these is the aggregate potential of the series to which they each belong. It may appear paradoxical that in the case of the second series the potential difference should be rising on its way down the further side in bars 15, 13, 11, and correspondingly up the front side, in a contrary direction to that in which the armature revolves; but this is the way the current goes in this series of sections, and it naturally forms its "head," or point of highest potential, at the end towards which it is tending.

We have thus far shown how the E.M.F. and current are induced. There are yet some further points in this connection to be referred to. The first which may be mentioned is one of no little importance. It will be remembered that the long bars down the sides of the armature have an increasing potential in their order from top to bottom; consequently and inversely, their respective short bars opposite have a potential increasing from bottom to top. It follows that in all cases where the sections are about horizontal, the currents in their respective parallel bars on both sides are of about the same potential; but at the top the short bars of the high potential come alternately with the long bars of low potential, and *vice versâ* at the bottom, the differences of potential increasing gradually from the sides toward the top and bottom, till at these latter points bars of maximum and minimum potential are lying adjacent. This constitutes an inherent evil of drum winding which cannot be eliminated. Another point to which attention may be drawn concerns the brushes. Should these be slipped round so as to come on the segments of the commutator 7 and 15, instead of 9 and 1, it might appear at first sight as though the current would be reversed in the outer circuit. But it would not be so, as the current would be reversed in bars 8 and 7, and 15 and 16, instead. In other words, the sections to which bars 7 and 15 belong would for the time become neutral, and the current continue to flow out at the lower brush, inasmuch as the pressure or potential in 7 is higher than that in 15. But as according to the principle already enunciated, whereby the highest potential must be at the bottom of the vertical plane of commutation, the effect of moving the lower brush on to 7 is simply to take it from a place of higher potential to that of a lower. Moving the brushes of course to points on the commutator other than of the maximum and minimum potential will reduce the E.M.F. in the outer circuit, the potential difference in the latter

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being in any case less than that in the armature, as otherwise there would be no flow of current into it.

We have, when mentioning the plane of commutation, alluded to this as only approximately vertical. It is in this connection that the polarisation of the iron core of the drum may now be considered. According to Ampère's well-known rule, the direction of the current round the horizontal sections of the winding will induce a north pole at the top of the core and a south pole at the bottom. With regard to the sections more nearly vertical, we may assume the plane of commutation to be exactly vertical, and so the bars 1 and 9 in our illustration to be exactly at the top and bottom respectively. We then observe that section 10—9 tends to produce a north pole on the *further* side of the core, while section 15—16 tends to produce a north pole on the *front* side; hence these two tendencies counteract each other. Intermediate sections, however, such as 11—10, 15—14, will tend to produce a north pole, the one on the further side of the top and the other on the nearer side. Hence the ultimate result will be a broadening of the poles at the top and bottom. But the effect of the magnets between whose pole-pieces the armature revolves is to induce poles at the *sides* of the armature, a north-pole on the further side and a south pole on the front, at right angles to the self-polarisation of the armature. Experience has shown that it is desirable to magnify this effect, and to make the enclosing magnets so powerful that they shall almost entirely overcome the self-polarisation of the armature. Hence ultimately, by a compromise, the north pole of the core becomes located a little above the horizontal on the further side next the S pole-piece, and the south pole of the core a little below the horizontal on the front side opposed to the N pole-piece. Thus the plane of polarisation of the core is a little tilted, and the lines of magnetic induction not quite horizontal, and the plane of commutation, as already explained, being at right angles to those, becomes a little out of the vertical, determining the lead of the brushes. The torque, or tangential pull on the drum, is of course represented by the attraction between the poles of the core and the contrary poles of the magnets to which they are respectively opposed, requiring power to overcome it.

THE SPRAGUE IMPROVED ELECTRIC RAILWAY MOTOR.*

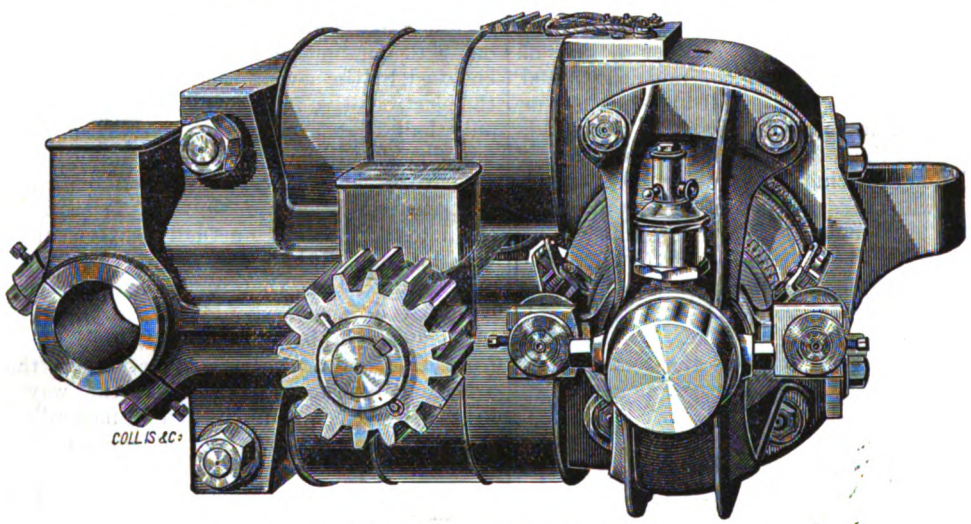

FIG. 1.—New Sprague Electric Railway Motor.

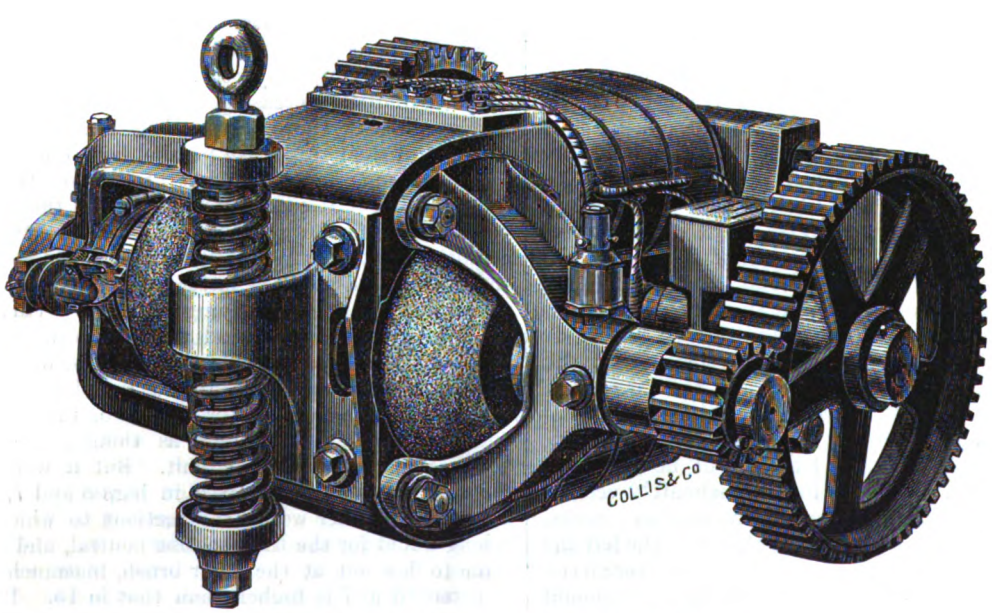

FIG. 2.—New Sprague Electric Railway Motor.

We publish in this issue two views, Figs. 1 and 2, of the Sprague improved electric motor for street railway work. Only one intermediate shaft is used between the armature pinion and the main gear, and the entire reduction is about 12 to 1. The main gears are of the split-gear pattern, so that in case of necessity they can be easily removed from the shaft without dismounting the machine. The pinion and all the bearings are also constructed so that they can be independently removed, if necessary. All the bearings are made as simple as possible and protected from the

* From the *Electrical World* of New York.

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weather by dust guards. The armatures are of the type which has been proved to be water-proof and incapable of injury by moisture. In a recent test upon one of these armatures, made at the Sprague factory at Schenectady, it was placed in a tub of fresh water and allowed to remain there for twenty-four hours, and then in a tub of salt water and once more submerged for the same time. After each of these baths the armature was placed in position in the motor and the machine was worked to one-third above its normal load, as measured by a dynamometer, for several hours without developing any trouble whatever. Another important improvement which has been adopted in this machine is that the field-magnet coils are completely incased, as shown in the engraving, a plan which fully protects the wire from all outside damage. These casings are hermetically closed, so that it is impossible for any moisture to affect the coils in any way. Besides acting as protectors against any moisture, these casings also have an important electrical action in protecting the coils, since, being made of copper, by inductive action they reduce to insignificance whatever extra current might be generated in the coils upon breaking the circuit. The regular Sprague graphite brush is used upon these motors, which has been shown to give such excellent results in this kind of work. The graphite, instead of cutting the surface of the commutator, as brushes made of copper and other materials have been proved to do, acts as a lubricant, keeping the commutator smooth, at the same time giving very good electrical connection. The method of flexibly suspending the motors, which is an original and very important feature of the Sprague system of railway work, and the method of starting, stopping and graduating the speed of the motor without the use of any wasteful resistance, is in use upon all the roads installed by the Sprague Electric Railway and Motor Company. A great deal of attention has been paid in the design of this motor to the matter of reducing the weight to a minimum while paying sufficient attention to durability and strength. With this object in view, cast iron has been dispensed with entirely in the magnetic circuit, and wrought iron substituted; the increased cost of this substitution is more than made up for in the increased efficiency obtained with the same weight.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July* 6, 1889.

An interesting article is published this month in the *North American Review* by Prof. R. T. Ely, one of our leading political economists, on the telegraph monopoly, advocating that the telegraphs should be turned over to the Government, for the reason that they constitute a natural monopoly, and should be controlled by the State, the only alternative being a private monopoly. Prof. Ely is known as a political economist of the Socialistic order, who believes that the State should own and operate such institutions as the railroads and telegraphs, as well as the post offices, while local communities should own and operate such things as waterworks, street car lines, gas works, and electric light plants. Some few months ago he appeared in print with regard to the advantages to be derived by a community from the operation of its own electric light plant, but the mistakes in his figures were at once pointed out by many of the practical men in the business, and the arguments that Prof. Ely offered are still wanting in a solid basis of fact. With regard to the telegraph question, Prof. Ely holds that there is no middle ground between the two alternatives of a private monopoly and a public monopoly, and as private monopolies are contrary to the spirit of American and English laws and institutions, the owners of the telegraph system must be compelled to relinquish their property and to hand it over to the Government to be operated as a public monopoly. With regard to the modern idea that such institutions as railroads and telegraphs can be left in private hands but may be subjected to Government regulation, Prof. Ely remarks that this means the interference of the Government in private affairs, complicating the Government functions, and opening the flood-gates of corruption. For these reasons he desires Government monopoly of the telegraph business, and thinks it desirable that our Government should purchase existing lines rather than compete with other lines. It follows, therefore, and, in fact, Prof. Ely admits as much, that the Government must not only buy the Western Union and Postal Telegraph Companies' lines and those of pretty well a hundred railroad companies, but must buy up the American Bell Telephone Company, the District Messenger Companies, and the Ticker Services. The Government must in fact go further than this, for Prof. Ely advocates a world telegraph union "that will be another one of those bonds which unite nations and make for national peace." Thus it appears the Government must also buy the Submarine Cables. Just how much money this represents it would be hard to say, but if we figure the telegraph systems of the country at $100,000,000, and the telephone at at least as much, it will be seen that not less than $250,000,000 would be required at the outset in order to enable the Government to follow the example of European countries. Prof. Ely does not think that this addition to the number of public employés would be in any sense a national danger, but holds, on the contrary, that it would at once tend to purify politics, and that the politicians of the country, finding themselves endowed with the disposal of several thousand new offices, would at once call for a most rigid and pure Civil Service system. It is to be feared that Prof. Ely is either of a very sanguine temperament, or else knows very little of "practical politics." As to the effect on the telegraph service of passing from private to public hands, Prof. Ely is of opinion that it would be a material improvement. Most Americans who go abroad have very little to say in favour of the Government telegraphs as they find them in Europe, but Prof. Ely cites one or two personal experiences to show that things are better managed in Europe telegraphically than they are here. Just at the present minute it cannot be said that the question thus agitated again by Prof. Ely is a burning one, but as it has been vigorously discussed before in Congress it may come up again at no distant date. In the meantime it is interesting to note the opinion of one of the Republican leaders, Mr. Chauncey M. Depew, who in an oration before the Law School at Yale, last week, expressed views decidedly opposite to those advocated by Prof. Ely. "The magnitude of modern enterprises," he says, "and the close competitions of business have rendered the massing of the money of the many into one company a necessity which seems to be steadily increasing. The only other suggestion for carrying on the great affairs essential to comfortable living in our complex civilisation is for the Government to conduct them all. But experience has demonstrated that then, as in the German railways, the people get the minimum of service for the maximum of price, and an army of office-holders keeps its party in power and prevents the reform of abuses or the remedy of wrongs. We meet the question better by a compromise, which may be wisely enlarged, of State and national supervision. That the Government should watch the management and bring it to frequent accountability, that it should firmly protect the public, the stockholder and the employés, is the present, if imperfect, solution of the corporation problem." I may say that as far as my own observation extends Mr. Depew's views have public endorsement, and that it is in this direction of Governmental supervision that the question will be settled.

Everybody, of course, admits the fact that there is at the present time a marked tendency towards concentration and consolidation of allied interests, and examples are to be found in the electrical field just as readily as there are in any other. Thus, for example, we have recently seen a combination in one large corporation of all the various Edison electric light interests. We now see a movement on foot for the consolidation of the various Westinghouse interests under one general management, to be known as the Westinghouse Electric and Manufacturing Company. It is stated that a proposition to this effect was made about the middle of last month, and that it came up again for consideration at the meeting of the Westinghouse Company held on June 27. The various electrical interests that will be affected are already large, owing to the phenomenally rapid growth of the Westinghouse Company and its absorption of various systems one after the other. There seems no reason to doubt that when all the affairs are subject to one management even greater progress will be made.

One of the subordinate Westinghouse companies is the Tesla, and I am inclined to think that in securing the services of such

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a bright electrician as Mr. Nikola Tesla, Mr. Westinghouse displayed more than his usual shrewdness and foresight. The Tesla motor, which was brought out last year, and was the subject of a remarkable Paper read before the American Institute of Electrical Engineers by Mr. Tesla himself, has already been illustrated and described in your columns from time to time. Mr Tesla is still working away at the general problem, and seems destined to reach remarkable and valuable results before he "gets through." It is well known that one of the difficulties in alternating-current motor work has been to secure some means for bringing the motor up to synchronism with the generator before the alternating-current from the generator can be applied to drive it. In order to effect the starting of the alternating motor, and bring it to synchronism without external aid, Mr. Tesla has now devised a simple system, in which he uses an earth return during the period of starting only, For this purpose he constructs a generator with two coils or sets of coils, and a motor with corresponding energising coils. By means of two line wires one terminal of each generator coil is connected to one terminal of its corresponding motor coil, while the opposite terminals of the generator coils are joined together, and those of the motor also. For starting the motor an electrical circuit is temporarily established between the points of connection of the coils in the generator and motor, so that the system becomes an ordinary double-circuit one. When by this plan the motor has attained the desired speed, the earth connection is severed, by which means the system becomes an ordinary single-circuit synchronising one. I may add that it is reported from Pittsburg, where naturally questions connected with alternating-current motors have unusual interest, that it is proposed to have an alternating motor car in operation this fall, and that great advantages will be gained by dispensing with the commutator and its attendant troubles.

An interesting Paper was read last week at the closing meeting of the season of the American Institute of Electrical Engineers, by Mr. Leo Daft, with regard to work that he has been doing on the New York elevated roads, and some of the results that he has obtained with regard to the question of fuel consumption. So much has been said and printed during the last three or four years with regard to the Daft system of electric propulsion, that Mr. Daft wisely took it for granted that his hearers would be familiar with the details of the system, and he did not therefore enter upon them except to mention that he still adhered, as the result of his work, to the opinion that it would be better to run the train by a single locomotive, as on steam roads, than to adopt the practice of putting one or two motors under each car and dispensing with the locomotive altogether. Mr. Daft also was at some pains to emphasise his belief in the superior tractive effect obtained from the passage of the current between the wheel of the electric locomotive and the track, and he holds that the increased traction is equal to at least 30 per cent., and he has often seen as high as 35 per cent. increase. He says, moreover, that the tractive efficiency of electric locomotives is higher than that of ordinary locomotives for mechanical reasons. With regard to the question of coal consumption, into which Mr. Daft entered very fully, illustrating the points made by numerous diagrams, it would appear that a marked increase of service would be obtained by the use of electric motors, with a coal consumption of not more than one-half that of the steam locomotives now in service on the elevated roads.

Turning from the important question of the successful operation of the elevated roads by electricity, we find that great strides are now being made in the improvement of apparatus intended for the electrical operation of the street railroad. The Sprague Electric Company have just published illustrations and descriptions of their new motor for street railway work.* It certainly appears to be about as compact, solid, and effective a piece of machinery as it is possible to devise at this stage of the art, and one from which any amount of good work may be confidently expected. These machines are already in use on the Sprague roads at Cincinnati, Cleveland, Atlantic City, and elsewhere, and are doing excellent work.

[* An illustrated description of this new motor will be found in another column.—Ed. *E.*]

The electric light companies of this city are now filing their bids for street work. About a month ago these bids were first sent in, but Mayor Grant kicked, with his usual affability, because the companies desired to charge more for the service in the subway districts than they did for that in districts where they could operate by wires and poles. The new bids average from 25 to 30 cents for lamps of 2,000 candle-power in overhead districts, and from 45 to 70 cents for lamps in subway districts. It remains to be seen whether these revised bids will meet with any more favour than the last. It will be noted that the companies remain firm in their intention to collect more money for lamps fed through the subways, and in view of the high charge made for the use of the subways the rate offered by the local companies is not at all out of the way.

It is interesting to note that a general order has just been issued by the Army Department to the effect that the American Morse code will hereafter be used by the army for all purposes of signalling, whether visual or acoustic. The use of the English Morse, or Continental code, is to be discontinued. This action, it appears, is taken on the recommendation of the chief signalling officer, who desires to simplify signalling instruction, and to be able to avail himself readily in war time for signalling of civilian telegraphers. While it is admitted that fewer errors are likely to occur in the use of the English Morse, it is considered that that system is slower than the American, and that its continued use, moreover, would involve the employment of specially-trained experts, whose numbers could not be increased in a hurry if desired.

CORRESPONDENCE.

HOURS OF LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read Mr. Wright's letter in reply to my inquiry about lighting hours, and circumstances in America must be widely different from those existing here if practice confirms the statements he has made.

First, I do not know what are the circumstances which cause so large a consumption during the day time, and next, I cannot understand how a large proportion of "business lighting" should increase the number of lighting hours instead of diminishing it, as such hours are shorter than those necessary for shops (except public-houses and hotels), and for all manufactories, except the very few who have to work all night.

With us, where the early closing system is in operation, the business hours of ordinary shops are very short. All the principal shops which employ a number of lights, and most of the smaller ones, are closed at 6 p.m., except on Saturday nights, when they remain open until from 7 to 9 p.m. I annex the number of hours under the circumstances, taking the average hour of closing on Saturdays as 8 p.m. :—

Lady Day quarter	114
Midsummer ditto	5
Michaelmas ditto	13
Christmas ditto	174
	106

If we make some allowance for lighting and extinguishing, 400 hours would cover the time of lighting.

In manufactories opening at 6 and closing at 6, the hours are :—

Lady Day quarter	174
Midsummer ditto	0
Michaelmas ditto	0
Christmas ditto	296
	470

or say 500 hours per annum. Average of both say 450 hours, so that in the case above given the "business" hours for lighting are shorter than those for domestic consumption, which counting only from dusk up to 10 o'clock, are 1,443, and to 11 o'clock 1,808. These latter hours embrace Sundays, which are excluded from the other schemes of lighting.

Of course in London hours are later in the shops, and allowing 7 o'clock for ordinary shops this would add about 200 hours

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to the annual consumption. I exclude hotels, &c., and there is a considerable day consumption in the Metropolis.

Now the effect of these figures is this, that a large amount of business, as compared with domestic consumption, would reduce instead of increasing the number of hours, and I am satisfied that your estimate of 700 to 800 hours founded on actual practice in this country is a liberal one.

I would require some fuller explanation than any Mr. Wright has given before I can see my way in an estimate of 2,095 hours per annum as an average.—Yours, &c.,

Cork, July 13th, 1889. DENNY LANE.

THE MAGNETIC PROPERTIES OF IRON AND NICKEL ALLOYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—I have recently been making some experiments on the magnetic properties of an alloy of iron and nickel. A statement of the result may be of interest to some of your readers. I am informed by Mr. Riley of the Steel Company of Scotland, who gave me the sample I have used, that it contains 24·5 per cent. of nickel and 0·85 per cent. of manganese. It proves to be almost non-magnetic, its permeability being only 1·4, much the same as that of manganese steel. On heating a block of the metal to a high temperature and allowing it to cool, and noting the temperatures at successive times, it is found that the curve expressing the relation between temperature and time exhibits no disturbance such as I have observed with wrought iron and steel. The non-magnetic properties of this material are very remarkable, both iron and nickel being strongly magnetic.—Yours, &c., J. HOPKINSON.

5, Victoria-street, S.W., July 15, 1889.

THE LONDON COUNTY COUNCIL AND THE METROPOLITAN ELECTRIC LIGHTING SCHEMES.

At the meeting of the London County Council last week, the following letter was read from the Board of Trade :—

"Board of Trade (Railway Department),
London, S.W., July 1st, 1889.

SIR,—I am desired by the Board of Trade to forward to you, for the information of the London County Council, copies of Provisional Orders which the Board of Trade have granted in the Metropolitan area under the Electric Lighting Acts, 1882 and 1888.

The County Council will observe that the provisions of the Orders vary in some particulars from the provisions contained in the Model Order, of which a copy was forwarded to you on the 12th ultimo (R 8,604).

Modifications have been introduced in consequence of representations made to the Board of Trade since the preparation of the Model Order.

In adopting them, the Board of Trade have had especial regard to the suggestions made by the Committee of the London County Council, with whom the Board of Trade have had the pleasure of discussing the subject, and clauses have been framed with the object, as far as possible, of giving effect to those suggestions.

It will be seen that a section has been introduced exempting from the powers of the Undertakers interference with embankments, parks, or open spaces, not forming part of any street vested in the London County Council.

The Committee were desirous that the public bridges vested in the Council should be included in this section; but no power is conferred by the Order to interfere with any portion of a public bridge other than the roadway over it, and the Board of Trade are of opinion that the provisions of sections 13 and 15 will sufficiently prevent any works likely to be detrimental to a bridge, and that, in this respect, a roadway over a bridge should be dealt with in the same way as a street repairable by a local authority.

In forwarding these Orders, I am again to thank the County Council and the Committee for the aid which they have given in the matter.—I am, Sir, your obedient servant, R. GIFFEN.

The Clerk to the London County Council,
Spring-gardens."

The Chairman of the Highways Committee said there were still several points in the Orders requiring amendment, and further conference with the Board of Trade would be necessary.

PARLIAMENTARY INTELLIGENCE.

The Select Committee on the Metropolitan Electric Lighting Schemes.

TUESDAY, JULY 16.

The Select Committee of the House of Commons appointed to consider and report upon the various Bills for confirming Provisional Orders granted by the Board of Trade for supplying electric light to districts within the metropolitan area met for the first time on Tuesday, Sir George Trevelyan in the chair, the other members of the Committee being Mr. Story-Maskelyne, Mr. Arthur Duncombe, and Sir Henry Roscoe.

Mr. PEMBER, Q.C., said that he appeared with Mr. Moulton, Q.C., and Mr. Lloyd, on behalf of the London Electric Supply Corporation in support of a Provisional Order issued by the Board of Trade conceding to the Company the right to supply electric light to the parishes of St. George (Hanover-square), St. James (Westminster), St. James and St. John (Clerkenwell), St. Mary (Newington), St. Saviour (Southwark), St. Olave (Southwark), Rotherhithe, Bermondsey, and Greenwich, and parts of the parishes of Chelsea, St. Martin-in-the-Fields, and St. Margaret and St. John the Evangelist (Westmister). The learned counsel observed that the preamble of the Bill was opposed only by the united parishes of St. Margaret and St. John, Westminster, but there were other petitions in regard to clauses. Probably the better course of procedure would be for the Committee to decide one way or the other upon the preamble and then to consider the question of clauses, the decision of the Committee upon which in the case of the first Provisional Order would probably govern the other cases.

Mr. SAUNDERS, Q.C., representing the Westminster Electric Supply Corporation, who were the promoters of the second Provisional Order contained in the Bill, concurred in Mr. Pember's suggestion.

Mr. FREEMAN, who appeared for the London County Council, remarked that his clients had no desire to throw out the preamble if they could secure the insertion of clauses to protect their interests. He thought it would be convenient that the various Bills should be considered practically together, although the points to be raised differed somewhat in the various cases.

Mr. POPE, Q.C., on behalf of the Gas Light and Coke Company, said the Committee would understand of course that his clients did not like the electric light, but at the same time they were not disposed to contest the preamble of the Bill. All they wanted was certain protecting clauses.

Mr. PEMBER, Q.C., then proceeded to further explain the Provisional Order granted by the Board of Trade to the London Electric Supply Corporation and to give details concerning the financial status of the Company. He described at considerable length the system which the London Electric Supply Corporation proposed to employ, and entered into the reasons which had induced his clients to set up a generating station at such a distance from the centres of supply. He concluded by saying that the Company feared no competition and asked no favours.

Mr. STORY-MASKELYNE asked why the promoters applied for the right of supplying only a part of the parishes of St. Margaret and St. John, Westminster?

Mr. PEMBER explained that for the present the Board of Trade had conceded the right of supply in a part of the united parishes to another company. The London Electric Supply Corporation asked for the right in respect only of so much of the united parishes as lay to the north of (but including) Westminster Bridge, Bridge-street, St. Margaret, Parliament-square, Broad Sanctuary, and Victoria-street. The opposition of the Vestry of St. Margaret and St. John to this Bill seemed to be based upon no intelligible principle. They simply placed their back to the wall and, without giving any reason, simply said, "We won't have the electric light."

Mr. POPE, Q.C.: They don't say so, and they don't think so. They simply object to this particular Order.

Mr. PEMBER observed that the Vestry professed to want further time for consideration, and they suggested that the alternating system to be adopted by the promoters would not work satisfactorily. He was quite prepared to go into that question if the Committee wished it, but that would involve a very long inquiry. The point upon which the Vestry seemed most to rely was that under the Act of 1888 a limited power of veto was given to the local authority. It was laid down in that Act that the Board of Trade should not grant any Provisional Order authorising the supply of electricity except with the consent of the local authority, or unless, in cases where that consent was refused, the Board, having regard to all the circumstances of the case, was of opinion that the consent should be dispensed with. In that event the Board was bound to make a report setting forth the grounds of its decision, and that had now been done. To keep the promoters out of the parish of St. Margaret and St. John would be to deny them access to the regions beyond and make it impossible for them to reach their customers. He could not believe that Parliament, in giving local authorities a right of veto, intended it to be applicable in the metropolis. In mapping out London for the general purposes of electric supply such a power of veto would be obviously absurd, although it might operate beneficially where the district to be served, as in Birmingham, was all under one local authority. The parish that was opposing this Order must, so to speak, pay the penalty of its geographical position. London could best be supplied with electricity by large and powerful companies working over large areas and possessing ample capital. That was the deliberate opinion of the Board of Trade, and in mapping out London on that principle they could not attend to the whims and caprices of every local authority. He respectfully submitted that as the Board of Trade was satisfied that the objections of the local authority ought to be dispensed with, the Committee had no jurisdiction in the matter.

Mr. POPE, Q.C., on behalf of the opposing Vestry, urged that the Board of Trade had not complied with the Act of Parliament, inasmuch as they

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had not given any grounds for dispensing with the consent of the local authority. The Act required them to state their reasons, and they had not done so. All the Board said upon the subject was that the Vestry had been so wanting in vigour in its opposition to the Bill that they had come to the conclusion that after all it would consent. He did not wish to raise any lengthy debate as to the electrical system to be adopted by the promoters, but he maintained that the Vestry was justified in asking that there should be a delay of at least another year before they should be asked to submit to the domination of a Company which, however wealthy and well able to carry out its work, might be experimentally unsound.

Mr. PEMBER having been heard in reply,

The CHAIRMAN said the Committee were clearly of opinion that they had power to go into the objections raised by the local authority, notwithstanding the decision of the Board of Trade to dispense with the local authority's consent. The special report of the Board of Trade as to their reasons for dispensing with the consent did not give the Committee all the information they desired. As to the method of supply proposed to be adopted by the promoters, the Committee did not wish to go behind Major Marindin's report.

Mr. MOULTON, Q.C., suggested that a witness should be called from the office of the Board of Trade, but Mr. Pope objected on the ground that the Board could not supplement by oral explanations a report required to be made by Act of Parliament.

After some discussion,

The CHAIRMAN said the Committee felt they must decide the case upon its merits. Without wishing to criticise the special report of the Board of Trade he must repeat that it did not give the Committee all the information they desired. On the other hand, it would not be proper to call the Board of Trade officials as witnesses unless they could be subjected to cross-examination.

In answer to Mr. Story-Maskelyne, Mr. POPE said he did not propose to call any witnesses. He would be content to leave the matter as it stood in Major Marindin's report.

The EARL OF CRAWFORD, examined by Mr. Moulton, said he was Chairman of the London Electric Supply Corporation, and had given great attention to the whole subject of the proposed working of the company, scientifically and financially. He believed the company to be sufficiently rich and powerful to carry out satisfactorily the work allotted to it by this Provisional Order. He believed the electric light would be much used in the district covered by the Provisional Order. Probably as many as 30,000 lights would be required in Victoria-street alone. The principal residents there were well-to-do occupants of flats who lived more luxuriously there than they would do in houses of their own.

Cross-examined by Mr. POPE, witness admitted that it would not be unreasonable for a local authority to wish to retain in its own hands the right of supplying the electric light if it showed any *bonâ fide* disposition to do it.

In answer to Mr. Freeman, LORD CRAWFORD said it was proposed to carry the mains over Westminster Bridge. He believed that that could be easily done without danger or inconvenience. It was true that arrangements might be made with the South-Eastern Railway Company to carry the mains over Charing Cross Bridge, but the promoters did not wish to place it in the hands of any company to be able to cut them off at any moment. He had considered the possibility of carrying the mains under the river, but there were practical and legal difficulties in the way. The promoters did not wish to be in a worse position than the gas and water companies, whose mains were carried over the bridges.

Mr. FREEMAN remarked that the gas and water companies acquired their powers before the bridges became public property.

The room was cleared, and on the readmission of the public,

The CHAIRMAN announced that the Committee found the preamble of the Bill proved, subject to the insertion of clauses providing for an audit of the company's finances, and imposing certain conditions as to the user of Westminster Bridge and the sufficient supply of electrical energy.

The Committee then adjourned.

Wednesday, July 17.

The Committee resumed their inquiry on Wednesday morning, Sir George Trevelyan in the chair.

Mr. POPE, Q.C., on behalf of the vestry of the united parishes of St. Margaret and St. John, Westminster, said that after the decision announced by the Committee on the previous day, he would reserve any further opposition, so that he might not be prejudiced when the Bill reached the other House.

Mr. SAUNDERS, Q.C., who appeared for the Westminster Electric Supply Corporation, hoped he might now take it that the preamble of the Bill was proved. He would call a witness if the Committee thought it necessary for him to do so. The Order which had been granted in favour of his clients was, except in regard to capital and works, in terms identical with that granted to the London Electric Supply Corporation. His clients were a modest company, created simply for the purpose of dealing with two districts in the west part of London, viz., the parish of St. George (Hanover-square) and a part of the united parishes of St. Margaret and St. John (Westminster). Over a certain portion of this area the London Electric Supply Corporation had also the right of supply. With the exception of the houses in Victoria-street, the district was a poor one. It was proposed to adopt the low tension continuous-current system. As the local authority had no objection to the Order asked for by the Westminster Electric Supply Corporation, he appealed with confidence to the Committee to confirm it. The Company had already expended a certain amount of capital, was thoroughly *bonâ fide*, and had its works in the actual neighbourhood that it proposed to supply, and it was not under the necessity of asking for permission to carry its mains over any of the Thames bridges.

The CHAIRMAN said the Committee were satisfied with the general statement they had heard, and Mr. Saunders need not call witnesses. The Provisional Order would be confirmed.

Provisional Order Bill No. 3 was next considered.

Mr. C. BAGGALLAY said he appeared in support of the Order granted by the Board of Trade to the House-to-House Electric Light Supply Company for portions of the parish of St. Mary Abbott, Kensington.

The CHAIRMAN said the Committee approved the Order.

Mr. SAUNDERS, Q.C., appeared to support the Provisional Order granted by the Board of Trade to the Kensington and Knightsbridge Electric Lighting Supply Company, which was to look after portions of the two parishes named. There was no opposition. They were already at work, supplying the Kensington Town Hall and other buildings. There was an increasing demand, and the company only awaited the Parliamentary confirmation of this Order to enable them to increase their generating stations, the land for which they had already acquired.

In reply to Sir H. Roscoe, the learned counsel said that his clients proposed to use the continuous current system.

The CHAIRMAN: We confirm the Provisional Order.

The next case was that of the Notting Hill Electric Lighting Company, whose Order was confirmed.

Mr. SYDNEY MORSE supported the Provisional Order of the Chelsea Electricity Supply Company having reference to a part of the parish of South Kensington (St. Mary Abbot). There was no opposition, and the Order was confirmed, as was also an Order in favour of the Electricity Supply Corporation for the district of St. Martin's-in-the-Fields.

On the application of Mr. CRIPPS the Committee also confirmed Provisional Orders conceding to the Metropolitan Electric Supply Company the right of providing electric light in the districts of St. Giles, Holborn, Strand, and St. Marylebone. An Order in favour of the same company in respect of Lambeth, Streatham, and Clapham was withdrawn, in consequence of the local authorities not having given their assent. Mr. Cripps stated, in answer to the Committee, that the Metropolitan Electric Supply Company would have a supply station on the south side of Waterloo Bridge, and that they would work generally on the alternating-current system, though they would have one station conducted on the direct-current system.

The Committee, having approved the preambles of all the Bills, proceeded to consider the clauses, and it was agreed to insert provisions as to the audit of accounts of the various companies. It was further suggested, at the instance of the London County Council (represented by Mr. Freeman) to make provision against the amalgamation of electric lighting companies, or the transfer of their Parliamentary powers, without the consent of the local authorities concerned.

Mr. GRAY, who appeared for the Board of Trade, said that with regard to one of the proposed amendments by the London County Council, it seemed to the Board of Trade to go directly in the teeth of the 11th section of the principal Act, which made the Board of Trade to be the authority which must consent to any consignment of powers.

Mr. FREEMAN denied that the proposed clause would override the principal Act, and said that he could not see that the Board of Trade had any ground for interfering when the promoters, the Committee, and the County Council had agreed to the clause.

The CHAIRMAN asked if the difficulty would not be removed by putting the clause in the confirming Bill.

Mr. GRAY said it was unusual for a Bill which had the effect of a special Act to use words overriding the principal Act.

The CHAIRMAN said that the Committee did not think they would be discharging themselves of their responsibility without seeing that any amalgamation of these important companies should be done in the full light of day and with the sanction of Parliament. The question was how this was to be done.

In answering, Mr. FREEMAN submitted that the clause would in no way interfere with the Board of Trade's power to grant new licenses. An amalgamation could not be made by a new license.

Mr. C. BAGGALLAY hoped that the clause would be framed so that the companies could associate for certain purposes, and thus economise their power.

Mr. FREEMAN said that they desired to guard against association as well as amalgamation.

The CHAIRMAN said that from Sir E. May's "Parliamentary Practice" it would appear that amending of the preamble was the proper method to carry out the intentions of the Committee.

Mr. FREEMAN said that the London Company had agreed to the clause, with the following addition, to which he assented:—"But this provision shall not prevent any temporary arrangement under which the Undertakers may obtain from any other Undertakers the supply of electricity with the consent of the Board of Trade and the County Council."

Mr. WALLACE said he must, on behalf of the Companies he represented, object to this amendment, which would be of no use to the London County Council.

Mr. GRAY objected to the amendment on the ground that it overrode a clause in the Provisional Order preventing one company supplying energy beyond its own legalised area of supply.

Mr. BAGGALLAY repeated his objection to the words "associate with," as being too wide. The company he represented would not object to any association requiring the consent of the Board of Trade, or to any amalgamation requiring the consent of Parliament.

Mr. CRIPPS said that the companies could not carry on their business with this non-association clause in.

Mr. MOULTON pointed out that it would prevent his company carrying out one of the purposes for which it was formed, viz., the supply of electrical energy to other companies.

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Mr. GRAY thought it was undesirable that there should be two authorities to give the consent for this temporary association.

The CHAIRMAN said that the Committee would require only the consent of the Board of Trade; and the words requiring the consent of the London County Council were accordingly struck out.

A clause was agreed to providing that 28 days' notice should be given by the Undertakers before commencing to lay mains in any street.

Mr. FREEMAN observed that the 28 days' was a compromise, although his clients (the London County Council) thought it too short a time.

Mr. MOULTON said: As to the arbitration in the case of carrying the supply over bridges, he felt it absolutely necessary that competent persons should be appointed as arbitrators, as there was a good deal of responsibility in arranging electrically how the supply was to be carried over, and a person not competent might not be able fully to appreciate the difficulties of the task he had to deal with. In case there should be a serious difficulty it was most important to the public that the matter should be decided upon by some impartial person appointed as the Committee might think fit.

Mr. FREEMAN then proceeded with Clause 13, and submitted that his clients having better knowledge of all the bridges, the crossing of the bridges should be subject to their direction.

The Committee having deliberated, the CHAIRMAN said the Committee were perfectly willing to give every possible guarantee to the County Council as to the method in which the bridges should be crossed. They wished to give the greatest latitude to the County Council in the matter of the arbitrator, but in the last resort the arbitrator must be appointed either by the Board of Trade or by someone else.

Mr. FREEMAN accepted that at once, and would endeavour to carry it out; but if, when the County Council came hereafter to consider it so important that the arbitration should not be put upon them, they reserved their rights.

The CHAIRMAN suggested that they should adjourn the gas clauses, not knowing how long they would take.

Mr. POPE thought the gas clauses might be disposed of to-morrow, and explained the mode of procedure he proposed to adopt with regard to them.

The Committee then adjourned till Thursday.

THURSDAY, July 18.

The Select Committee for the consideration of these Bills held its third meeting yesterday (Thursday).

Mr. MOULTON, Q.C., said the only remaining opposition to clauses was from the Gas Light and Coke Company, and he proposed now to bring the clauses of the Bill before the Committee.

Mr. POPE, Q.C., objected to this on the ground that the promoters were adhering to the clauses in the Provisional Order; he was entitled to bring forward his clauses, which would give him the right of reply.

The CHAIRMAN ruled that Mr. Pope should bring forward his clauses.

Mr. POPE said the discussion would practically settle the Model clauses for all such Bills in future, and for all gas companies. His clients did not desire to put forward clauses merely to obstruct the competition in lighting which the Bill would set up, but only wished that wrong and injustice should not be done to those already in possession of the field. The position of the gas company was that they were entitled to precisely the same protection for their pipes as any other owners of property were entitled to. If the electric company happened to damage the pipes of the gas company the latter were entitled to bring an action at law against the former unless the work they were doing was protected by Act of Parliament, and the Provisional Order had practically the same effect as an Act of Parliament in that respect. His clients wanted to secure that no damage should be done to the Gas Company's works, and that the construction of the electric works should be such as not to make it difficult for and impede the Gas Company in getting at their works for the purpose of perfecting their supply. He then proceeded to place the clauses before the Committee.

Mr. J. O. PHILLIPS, secretary and manager of the Gas Light and Coke Company, examined by Mr. BIDDER, gave details of the affairs and works of the company, in the course of which he said they had laid 1,850 miles of mains in their district of supply. It was very necessary that they should be protection clauses, as any damage to their pipes might cause a stoppage of the gas supply which might lead to serious consequences, especially as the signal lights of the Metropolitan Railway were lighted by their gas. His company desired proper notice of the works of the Electric Company, so that one of their officers might be present to see that no damage was done to the pipes; they wanted no favour. He suggested that the electric mains should be laid not less than five feet from the gas mains, and that the Gas Company should have a fortnight's notice of any works being done by the Electric Company.

Mr. C. WOODALL, civil engineer, called by Mr. BIDDER, said there must be a certain inclination in gas pipes, and so it was of importance that the gas company should make any alteration in them which was necessary. The pipes required frequent examination and renewal, and it was important that nothing should be placed over them which would prevent such work. Protection was alike necessary when gas pipes were interfered with, or works undertaken near them. He thought an absolute distance of 5ft. from the gas mains would be excessive, and that a limitation was undesirable. It would be better to give notice to the companies interested. In answer to Mr. Moulton, he said he thought a week's notice was fair for all new works, but there were special cases when less should be required.

Mr. MOULTON said his clients would not object to that.

WITNESS said he thought the gas companies should superintend the carrying out of the works as well as the digging of the trenches.

Mr. MOULTON again said his clients would not object to that.

WITNESS, in reply to Mr. Moulton, said he should like to see clause 17, relating to new works, agree more with clause 16, relating to repairs. He wanted the gas company to have an alternative to do the works, other than electric works, and to let the Electric Company have a similar right in works other than gas works.

It was explained to the Committee that the Court, which would have jurisdiction under Section 17, was that of a metropolitan police magistrate.

In further cross-examination, WITNESS said he thought it was better to give the gas company an alternative to do the work, instead of arbitration, which would delay the work.

Mr. G. C. TREWBY, engineer to the Gaslight and Coke Company, also gave evidence as to the necessity of notice, and

The CHAIRMAN said the Committee quite recognised the seriousness of full notice, and of the gas and electric companies working together in laying down the pipes.

WITNESS proceeding, said that 48 hours' notice of new works was insufficient for them to ascertain what was necessary by way of precaution. So far as he knew no damage had been done to their mains by the Knightsbridge culvert, but as the ground had been filled in they really did not know how the work was done.

Mr. MOULTON, after some discussion, said his clients were ready to amend clause 17 so as to give seven days' notice instead of 48 hours' notice, to give a right of superintendence of the execution of the work mentioned in the clause, and to give the Gas Company the option of themselves performing the work exclusive of the electrical part, if the London County Council did not exercise the prior option which they had under the Bill.

Mr. BIDDER said he accepted the compromise, except as to notice, which he still held should be fourteen days.

Some discussion then took place, in the course of which Mr. MOULTON agreed that no part of the gas mains should be used as an electric circuit or as a pediment for the electric companies works, and that the method of insulation should be decided by an arbitrator to be appointed by the Board of Trade.

Mr. BIDDER accepted those points, and clauses were to be drawn accordingly.

Mr. MOULTON promised to bring up a clause providing for arbitration in case of dispute, under section 17.

The Committee then adjourned, it being understood that the clauses should be brought up at this day's (Friday's) sitting.

COMPANIES' MEETINGS & REPORTS.

The Eastern Telegraph Company (Limited).

The thirty-fourth half-yearly ordinary general meeting of this Company was held yesterday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. George Draper) read the notice calling the meeting and the minutes of the last half-yearly meeting, which were confirmed by the present meeting.

The report of the Directors was taken as read.

The CHAIRMAN said that the report was very full and very instructive, and he hoped it would be thought a very satisfactory one by the shareholders. The revenue account for the half-year ended March, 1889, showed a total amount for messages of £352,791, being an increase over the corresponding half of 1888 of £28,647. About two-thirds of this increase arose from their South African traffic and from the political disturbances which had been going on at Zanzibar. The South African traffic had been largely developed by the mining enterprises, and they were sanguine that even in ordinary times the traffic would be a satisfactory and increasing one. Holding these views, they had, in concert with the Eastern and South African Company, organised a complete alternative system of telegraphy to the Cape *vid* the West Coast. This growth of traffic had enabled the South African Company (the greater part of whose capital was held by the Eastern Company) to pay a largely increased bonus. The shares of the Eastern and South African Company were all but entirely held by the Eastern Company. The revenue account showed that the Eastern Company had received as dividend £79,650, against £31,200 in the corresponding half-year. The £79,650, however, included an exceptionally large bonus from the South African Company. He was pleased to say that their Egyptian traffic, which had been steadily declining for some years, showed an increase in the past six months as compared with 1888. One class of traffic, namely, the Indian, showed a substantial decrease. This falling off, which amounted in the past half-year to £5,500, was engaging their serious attention. Their Black Sea dividend was the same as last time, but their investment in the Direct Spanish Company was £184 less. To sum up, their gross revenue from all sources for the half-year was £435,932, or an increase of £76,226 over that of the same half of 1888. The total working expenses for the half year had been £92,448, showing an increase of £5,314. In giving the details of the increases and decreases in the expenses, he stated that the increase in the expenses at the stations had been owing in a great measure to the addition to their foreign staff, consequent upon the opening of the triplicate cable from Porthcurnow to Lisbon, Gibraltar, and Malta, and the extension to Zante, and to the opening of a new station at Cadiz, they having put that place in telegraphic communication with Villa Real and Gibraltar. It had also been necessary to augment their staff at other stations. As compared with March, 1888, the total increase in the number of their staff at the stations was 41. To meet the requirements of the traffic they had found it

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necessary to add to the accommodation of several of their stations, more particularly in London and at their training school at Porthcurnow and also at Carcavellos, Malta, Alexandria, Suez, Syra, &c. The repairs to the cables in the half-year had cost £48,665, or £10,253 more. The expenses of five ships were included this half-year, against four in the same period of 1888, and also the cost of 203 knots of cable used in repairs and renewals, the greater portion of which was used in the extensive repairs to their No. 1 Aden-Bombay cable. The total increase in their revenue had enabled them to meet the additional expenses incurred during the half-year, and to pay an extra ½ per cent. bonus on the ordinary shares, including the 20,000 additional shares issued to enable them to take up a like number of ordinary shares of the Eastern and South African Company. They had placed £118,000 to the reserve fund, against £75,000 last year. The reserve fund, with interest received on investments during the half-year, the premium on the issue of new shares, the profit on the sale of Direct Spanish Company's Debentures, and the contribution from revenue account (£118,000) for the year ended 31st March last, now amounted to just over half a million. They had spent on their system out of their reserve and revenue accounts £782,000, and he thought that showed they were in a most satisfactory position. Their object was to keep down the capital as much as possible, and at the same time maintain such an efficient system as would command the support of the public and lead to a still further development of the telegraphic system. At the last meeting he told them that they were engaged in a very great and important work, the laying and completing of a system of submarine telegraphy round Africa by the West Coast. They had just completed that work, which was probably the most important work yet done in submarine telegraphy. But the surrounding of Africa by submarine cables could not have been done except by organisation. In early days they showed that unless the West Coast cables were extended to the Cape the two or three existing companies could do no good whatever. They, however, felt that the traffic to the Cape was such that it had become necessary for them either to duplicate their system on the East Coast or lay an alternative line by the West Coast. After due consideration they adopted the latter course, and he might say that England, Portugal, France, Spain, the Cape of Good Hope, and Natal were all more or less directly interested in these cables, and had given their support to the great work which had been finished. It was a remarkable fact that while the Eastern Company during the last fifteen years, owing to the growth of business and extension of their system, had increased the volume of traffic 370 per cent. their income had not increased more than 100 per cent. The fact was that they had some very clever people to deal with, the merchants having brought their coding systems to such a high state of perfection. Further reductions in the rates were, however, sometimes talked about, but they could not reduce the rates unless they could increase their traffic and income. He thought that the distribution they were declaring that day must be generally accepted as a fair and satisfactory one. Notwithstanding what he would call the very encouraging prospects and the solid position of their Company, they had a great deal of work before them yet. Some of their cables were getting old, and they wanted to increase their capital as little as possible. They looked to a very large increase in their Australian traffic, in connection with which they would probably have to make reductions in the tariff, but they would take care, if anything of the same nature were suggested with the Indian traffic, to see their way very clearly before they made any alteration. One of their cables, from Aden to Bombay, required very special attention, and if the traffic increased as they expected, and as it was doing, to Australia and other parts, they would require to put down another cable, not only between Aden and Bombay, but from Marseilles to Egypt, to give them perfect security and safety. While carrying out the very great work which the share holders would themselves see had to be done, the Directors would endeavour to maintain the income of the Company, and while adding to the value of their property and not increasing the capital they would try and make the same satisfactory dividend as they now had the pleasure of proposing. He concluded by moving a resolution adopting the report and accounts, declaring a dividend on the preference shares at the rate of 6 per cent. per annum, less income-tax, paying a dividend of 2s. 6d. a share, with a bonus of 3s. a share, tax free, on the ordinary shares, making, with previous payments, 6½ per cent. on the ordinary shares for the year ended March 31st, 1889.

The VICE-CHAIRMAN (the Marquis of Tweeddale) seconded the motion, which, after some discussion, was adopted.

On the motion of Mr. JOHN NEWTON, seconded by Dr. WALLER, a vote of thanks to the Chairman and Directors was passed, and the proceedings then terminated.

A full report will appear in our next issue.

Telegraph Construction and Maintenance Company (Limited).

A half-yearly general meeting of this Company was held on Tuesday, at the offices, 38, Old Broad-street, Mr. P. Rawson presiding.

The MANAGING DIRECTOR having read the notice calling the meeting,

The CHAIRMAN expressed regret at the absence of Sir Daniel Gooch, the Chairman of the Company, and said: This meeting, as you are aware, is nothing more than a formal one. We have no resolutions to propose, nor any report to lay before you.* The warrants for the interim dividend will be posted this afternoon. I have very little to say to you. I will just lay before you a synopsis of what we have done during the half-year which has just passed. We have done a fair share of cable work during the half-year, especially as regards the wire-covering and other general business of the Company. Our ships have been engaged in triplicating a portion of the Eastern Extension Company's system between Java and Western Australia, and in laying a line between the Cape and the Portuguese settlement of Mossamedes, on the West Coast of Africa. We have also effected some cable repairs on the west side of the Atlantic, and the steamship "Calabria" continues on the charter she was engaged in at the time of the last annua report.

The proceedings then terminated.

* The interim dividend was 12s. per share, as announced in *The Electrician* of July 5.

London Electric Supply Corporation (Limited).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel on the 15th inst., under the presidency of the Earl of Crawford.

The MANAGER and SECRETARY (Mr. Charles B. Waller) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen—We have met here to-day in order to carry out the promise which your Board made to you at the time of the last meeting. They then presented their annual report to you, and told you they were about to lay the accounts of the past year before you. The business that we have to-day is to lay those accounts before you, with a copy of which you have been supplied. Before going into any question of these accounts I wish to inform the shareholders officially now that their Board has been materially strengthened by the addition thereto of Mr. J. S. Forbes, who has come upon the directorate as Vice-Chairman and Chairman of the Finance Committee. Your Board, in requesting Mr. Forbes to take this position among them, thought they were doing their very best for the interests of the shareholders in carrying out this arrangement. Mr. Forbes has been good enough to go very carefully into all matters relating to finance, and he will explain to you the whole of these accounts which are laid before you. I may say that the form in which the accounts have been presented and produced now is mainly upon the lines laid down by the Board of Trade for the accounts which are to be presented by all the electrical companies in future. They are based somewhat on the lines of the accounts produced annually and laid before Parliament by gas companies, and I think that anyone who knows anything about figures will be able to see from them how we stand as far as our financial position is concerned. Without going further into them, I will move—

"*That the accounts now submitted be and are hereby approved.*"

And I will ask Mr. Forbes to go into the question of accounts, and also to answer any question that any shareholder may desire to know.

Mr. J. S. FORBES, in seconding the motion, in the course of his remarks, said: It is very desirable at starting that the proprietors should be thoroughly versed in the manner in which the accounts have been stated. They ought to have been submitted for the year ended December 31, but there were reasons which prevented that from being done, and the Directors thought it would be desirable, as some considerable time has elapsed since then, that you should be, so to speak, posted to date. They, therefore, upon the first sheet of the accounts set forth the statement of capital at the various periods—the statement of share and loan capital at the 31st December, 1888, and the 31st March, 1889. Since December, as you were made aware at the special meeting, there has been an alteration in the method of raising the capital of the Company, and that is shown in the statement to March. The capital of the Company is £1,000,000, divided into 200,000 ordinary shares of £5 each, authorised by the Memorandum of Association and the Articles, and £536,300 of that amount has been called up. Then, in accordance with the resolution of the annual meeting held in December last, £250,000 of preference capital was authorised, in 50,000 shares of £5 each, of which £1 a share has been called up. The amount of capital called up was therefore at the 31st March £586,300. There remains unissued £445,000 of ordinary share capital, £200,000 of preference capital, and £18,700 of the ordinary capital, being the £1 a share that is unpaid on the 18,700 shares on which £4 each has been called up. Having all this capital still to call up is a material fact, in this sense—that the authorities in dealing with the applications of electric light companies for licenses for supplying certain districts require strong assurances that they are not mere bogus companies who intend to hawk about the rights they may acquire and dispose of them to someone else. They will, therefore, only entrust such licenses to companies having a substantial backbone, as your Company has. The way in which the money called up has been disposed of is also shown. Up to December 31 you see that £374,617 was expended, and as the works are going on further money has been spent from day to day. During the quarter ended March £18,340 has been added to the expenditure, so that the outlay has been £392,957 up to that date, and the balance to the credit of the capital account was then £193,342. One has to consider the application of this large sum of money, and how far the experience of the working justifies that expenditure and justifies the hope which is entertained very strongly on the Directors' side of the table that the money has been very wisely spent in a sound enterprise, and one which is likely to be very soon, if not immediately profitable. The revenue account to December 31 has been made out in great detail in order to supply the fullest information as to the expenditure under the headings of generation of electricity, distribution of electricity, rent, rates and taxes, management, legal expenses, &c. You have two generating stations, the Grosvenor Gallery station, which is the active generator at the present moment, and you have the great work which is being carried out at Deptford, which in course of time will supersede the Grosvenor Gallery station. These expenses represent, so to speak, the cost of production of your article, which is made in one place and distributed, by a total different process, to a great number of other

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places. On the opposite side of the revenue account you see the kernel of the nut—the result of this large expenditure. I assume that no shareholder would suppose that a business of this sort, so very novel and having to contend with such great difficulties, would in the first period of its existence at once burst out into a position of great prosperity. What we have to consider is whether the initiatory period, which must of necessity involve great expenditure on the one hand, and comparatively small revenue on the other, is of such a character as to induce in the minds of business men the belief that the undertaking is sound. Having gone through the revenue account to December 31st, he said: It therefore seems that during these fifteen months of what may be called the inception of the business there was really a slight loss—the income was absorbed by the working expenses. In that period, however, the business was of a broken kind; there were few customers compared with the expenses of generation, distribution, and the fixed charges, and probably a great deal of the current that was generated was not utilised at all. I think I may say, in general terms, that if all the current that was produced in this period could have been distributed, sold, and paid for, the result, instead of being a small balance against you, would have been a sensible balance in your favour. In order to test whether the result to December was a fair start, we have made a revenue account for the first three months of this year, to March 31st—a period during which the thing was still in a transition state. Customers and the public are slow to follow in these cases. A great many wait to see what will turn up. They do not believe that the price charged is the lowest, or that the supply offered is the most efficient, and they go on waiting from month to month—and perhaps they act wisely. They will, however, come in when they know that they are dealing with a company properly constituted, with legal responsibilities, and with the power to perform them. Now, turning to the revenue account for the three months to March 31, you see that there is a change for the better. Instead of there being a loss of £382, as there was on the working for the fifteen months up to December, there is a profit of £548. That is not a large profit upon the capital that is spent. It is only useful in indicating that we have, as it is called, "turned the corner;" and the same observations I have made as to the generation and distribution of electricity hold as good in connection with the three months I am now dealing with as they did in the previous fifteen months—that is to say, if all the electricity generated had been sold and paid for the result shown would be very different. What is going on is this:—Knowledge and experience and scientific investigation are bringing the thing into harmony, and from three months to three months you will see much more of an equilibrium than you do at the present time. What the Board are waiting for is the completion of the great works at Deptford. Those works are of course very bold and very costly, but they will, when finished, do at a comparatively small relative charge what smaller works could not have done. They will put you in a position to meet an enormous increased demand upon you at a cost which could not be achieved by any multiplication of business upon a much smaller scale. The principle is at once to create an enormous amount of electricity, and by conducting it to various parts of London to reduce the cost of production and the fixed charges of production to the lowest possible figure *pro rata* to the amount of current generated, distributed and sold. I think I have said enough upon the question of the revenue accounts. They are really only useful at this stage of the Company's existence as, first of all, stating intelligently the outgoing and incoming element, and in showing also that although the fifteen months' working to December was not profitable to look upon, the working for the three months to March, under the influence of more experience, reduced cost, and more customers, has presented rather a better aspect; and I need not tell you that if that £548 for the quarter goes on rapidly increasing, as it probably will—as every member of the Board thinks it will—when the Directors meet you in future the result will be a great deal more satisfactory. The balance sheet is brought down to the 31st March, but I do not know that I need make any remarks on it, though if any shareholder desires any information upon it I shall be glad to supply it. I now second the resolution.

Mr. KISCH inquired the meaning of the item of debenture discount, £3,000 in the general balance-sheet on December 31, how it was that that item had risen to £30,000 by March 31, and how such an item at all was consistent with the statement on the first page of the accounts, that the loan capital on March 31 was *nil?*

Mr. FORBES replied that the item of loans has disappeared entirely by the 31st March. At the beginning, the Company, under the sanction of a general meeting, raised money by debentures—they were authorised to raise £180,000 at 4 per cent., the price of issue being £120 of debentures for £100 of cash. It was thought later on that it was unwise to have any mortgage debt in such a Company, and the debenture holders, in the exercise of the option given to them, took ordinary shares. He thought that this change was a very wise one in the interests of the Company. In further reply, Mr. Forbes stated that the expenditure at the Grosvenor Gallery since the 31st December, up to March, had been only £30.

The CHAIRMAN, in answer to another question, stated that the sum of £211,000 represented the price of the undertaking taken over by the present Company. It included the whole of the mains laid up to that time—about 60 miles laid all over London, the machinery then in existence, and the whole of the freehold property at Deptford.

The motion was then put in the usual way, and was carried.

The CHAIRMAN: That concludes the work that we have practically to do to-day, but I think I should say a few words on the present state of your property, and on what has occurred since I had the pleasure of addressing you on the 21st December last. At that time I told the shareholders that we were doing all we possibly could with respect to obtaining the Parliamentary powers which were necessary for us to do our work underground instead of working overhead. Overhead cables, no doubt, are a very useful means of going about London or any place, but they entail considerable labour and risk to ourselves. When I say risk I do not mean risk of danger, but risk of interference owing to the impossibility of our obtaining any permanency for those cables, because they are always at the mercy of a single individual, who says, "Take the pole off my house," and if you have to do that, you have to cut off the whole circuit of which that pole is a small portion. On the 21st December we had prepared (and I showed you at that time) the proposal we were then placing before the Board of Trade, laying out the form in which we desired to have statutory powers. I then showed you a large map coloured, with a great stroke of red on it, showing that we were proposing to take powers over a very large portion of the metropolis. After that time passed we had many interviews with the local authorities, and we had to modify, in many cases, the ideas we had formed, in order to meet their views. We had interviews with local authorities, vestries, and all the persons interested in what we were proposing to do—that is, to break up the streets. Having arranged as nearly as possible with them, we went to the Board of Trade at a certain date, and presented our proposed order. The action of the Board of Trade then began, and we had many interviews, but we could not persuade that body to adopt our views altogether, and they determined at the instance of the local authorities and others to hold what is called a local inquiry. That local inquiry was commenced on the 3rd of April. It held a continuous sitting for a period of eighteen days. During that time Major Marindin, who was appointed Inspector to report on those Provisional Orders to the Board of Trade, had before him all the objections that could have been raised to the Orders. He had before him all the different areas which the various companies desired to have. He considered these matters, and in the course of time he made a report to the Board of Trade stating what in his view ought to be carried out. That report has been presented to Parliament and can be obtained by anyone for 5½d. It contains the report of Major Marindin *in extenso*. It contains also certain correspondence between the Board of Trade and the County Council, and at the end of it, it contains a Model Order which the Board of Trade drew up—the model form of a Provisional Order in which they practically lay down that every one working in the Metropolis is to be put exactly on the same lines. With respect to what Major Marindin gave out in his report I have no objection to take to it in so far as it affects our interests. On the contrary, I am perfectly well satisfied with what he offered us, and I think that the proprietors of this great business will have every reason also to be satisfied with it. We have been given powers over 13 local authorities in London. Beginning in Deptford, we have the Greenwich parish, Rotherhithe, Bermondsey, St. Saviours, St. Olaves, a portion of Lambeth, Chelsea, St. Margarets, and St. John's, Westminster; St. George's, Hanover-square, St. James's, Westminster, and a portion of St. Martin's-in-the-Fields. That was the recommendation that Major Marindin made. He also said if we had any means of obtaining access into Clerkenwell that that parish should be added to our Orders. We were fortunate in being able to make arrangements with the railway companies giving us access to that district, and Clerkenwell has accordingly been added to that Order. Since the time that that recommendation was made, the parish of Newington, in South London, appealed to the Board of Trade, saying that they would be deprived of the light unless they came to us, so the Board of Trade have added Newington. We have, therefore, now a very large area. The main principle of Major Marindin's report was, that where it is possible two companies should be put into the same area. That I had the honour to state to you was entirely our view—that we were opposed to monopoly *per se*, that we were perfectly willing, where we had powers, that other companies should have powers also, relying upon our being able to do the work in a proper and business-like manner. The area where we have competition at present is St. George's, Hanover-square. We have there against us, or I should say more properly alongside of us, the Westminster Company. Similarly that Company has power over St. Margaret's, Westminster. In Chelsea we have the Chelsea Company alongside of us. In the portion of St. Martin's that we have, we have alongside of us the Metropolitan Company, and again that Company extends its powers over a small portion of Lambeth parish, over which we have taken jurisdiction. The parts lying to the east of Lambeth on the south side of the river are at present served by us alone. No company has yet been promoted for working that district, though, no doubt, in future some other companies will come and seek to have power with us. We shall not be against them, and so far as we can, we shall be ready to offer them facilities. There was one important recommendation of Major Marindin's report to this effect: In our generating station at Deptford he thought that it would be desirable to split up the building into two portions longitudinally. He put in his report that the building must be subdivided in such manner, or else that we should have a further generating station at another point. I was able to show him that the dividing up of the engine room as he suggested was not feasible, and also that the dividing it up as he suggested would not really carry out the objects honestly which he wished to see; that is, that every large engine should be insulated practically—have a wall or something like that between it and its neighbour. I also showed that the advantage to the public was one with an advantage to the shareholders in saying that if anything is to be done to our generating station the money had far better be placed in another place—in another generating station in another quarter of London, also advantageously situated as regards the getting of coal, labour, and so forth. The Board of Trade were willing to agree to that, and they will, therefore, call upon us in a short time to commence the erection of another station in another place. Instead of putting straight away now four large machines at Deptford, we are to put two at Deptford and two at the other place, and shall have a far better reserve of power, so that in case of a breakdown at either place we should have the other station at which to carry on the work. I think the actual difference of expenditure that will be caused to the proprietors will not be very great, but merely the expense of obtaining the land and buildings.

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The machines will be put into the two different buildings instead of one. Later on, when we have to add to our plant, one machine will go to Deptford and one to the other place as a reserve. As to what has occurred since I last addressed you, on the 21st December, you will remember that early in April last year we commenced working upon our Deptford land. That land was then perfectly rugged. Hardly anything was done on it except the pulling down of some brick sheds. Since then we have put up a very large building indeed, and are in a very fair way of commencing active operations there. We have put up a building consisting of boiler houses, engine houses, &c., covering an area of 40,000 square feet. The cubic capacity of the buildings runs up to something like 3,000,000 cubic feet. We have erected boilers to the extent of 12,000 horse-power. The boilers have been tested up to 300lb., and are again being tested at a higher rate, and have been under steam. We have erected and run two engines of 1,500 horse-power each, which can be started and worked in a very short time now. Possibly many of you may remember that a short time ago we had an unfortunate accident throught a steam pipe breaking. It was practically through no fault of the Board or of any one as it was owing to the inherent qualities of copper when under pressure. When soldered it is impossible to know how these copper pipes will be acted upon by steam. However, it is the best means known of working. That accident, which I regret to say resulted in the death of an unfortunate labourer, caused us to take down the steam connections from the engines and re-test them up to a much higher pressure than previously, and these connections are being again made. I trust in a few days that the engines will be actually working. The dynamos to be worked by these 1,500 horse-power engines are in a very far advanced state of completion. We expect in a short time to have these two machines working, each machine being able to do more than the Grosvenor Station is able to do at present. We have made arrangements that the very moment we start at Deptford we shall be able to relieve the work at the Grosvenor Station to the extent of something like 15,000 or 16,000 lights from Deptford. The Grosvenor Station, I think, as noted just now, will be done away with in the course of time. That is the case, but we do not wish to stop the working at that station until we can conveniently dispense with it. I suppose, therefore, it will go on for four or five months longer. We shall certainly be able to work our Deptford Station before the powers we seek to obtain will be afforded to us. That is to say when Parliament is good enough to confirm the Order made by the Board of Trade we have certain formalities to go through with those Orders which are laid upon us before we can do anything to the streets. We cannot in future erect overhead cables, but must put them underground, and I here may say that the depreciation underground is nothing to what it is overhead. Among the formalities that we have to go through is one that notice of a month has to be given to the local authority, County Council, Postmaster-General, gas and water companies, and everyone else before we are allowed to break the ground If we got our Order this month you might assume that we could begin in September, but that is not the case, for all the local authorities put in the Order a clause where they state that no part of the month of August should be counted as a month. We shall only, therefore, be able to give one month's notice on the 1st September, and we shall begin to break ground on the 1st October. I have no hesitation in saying that before that time we shall have everything ready at Deptford for supplying the current and of relieving the Grosvenor Station of some 16,000 lights. We have been able to make arrangements that will enable us to do that without incurring any additional expense. The first two large engines that I alluded to last time and which were authorised by the meeting formally—the 10,000 horse-power machines—are well advanced. The main difficulty of this operation was to get what is known as the crank shafts of the dynamos. These crank shafts have been cast in Scotland. They are of steel, and the casting was over 75 tons in weight. The shafts when finished will weigh over 60 tons, and I think the magnitude of our undertaking will be understood when I tell you that this was the largest casting ever made in Scotland. We have two of these machines in hand, and as a wise precaution we thought it well to order three of these shafts, so that they will be ready should anything happen to either of the other two, or for putting in a third machine when it is necessary for us to do so. The engines for driving these two large dynamos are ready for delivery when we are ready to receive them. The wharf which runs along the river frontage for 195 feet is entirely finished. We have got a large steam crane upon it capable of making a lift of 50 tons all in order. We have made a railway from the river front right through the property to the street frontage of our premises, and the permanent way is thoroughly satisfactory in all respects. We have two travelling cranes working on it, each lifting and moving about ten tons, and in one engine-room we have a travelling crane capable of working 25 tons, and in the other a travelling crane capable of working 50 tons. The other important part of the work finished since we last met is the main-making machinery. That has got to a state of efficiency, which leaves very little to be desired. We are able to receive the copper in tubes, make the insulation, put on the outside tube, and insulate again at very considerable speed—and without requiring any very great-skilled labour—an important point. The work is almost automatic. Each of these main-making machines is capable of turning out about a-half mile of main a day, so that you see we are well within our capabilities of working. In fact, I think the mains will be put out faster than we can open the ground to receive them. I do not know anything else to mention that would interest you or that I have omitted to tell you. I think altogether you have every reason to be satisfied with your property, and I am sure that anything that can be done by the Directors to enhance its value will be done as it always has been done. I think that concludes the business of the meeting.

On the motion of Sir PHILIP MAGNUS, seconded by Mr. R. I. WALLER, a vote of thanks was passed to the Chairman and Directors for the care which they have taken in carrying out the works of the Company and promoting its welfare.

The CHAIRMAN briefly returned thanks, and the proceedings terminated.

The Direct United States Cable Company (Limited).

The following is the report of the directors for the six months ended 30th June last, to be presented at the twenty-fourth ordinary general meeting of the Company, to be held at Winchester House, 50, Old Broad-street, E.C., on Friday, the 26th inst., at two p.m. :—

1. The usual statements of account for the half-year ended 30th June, 1889, accompany this report, and together with the half-year's accounts to 31st December last, presented at the ordinary general meeting on the 25th January last, show the financial result of the twelfth year's working of the Company.

2. The half-year's revenue (still subject to revision) including income-tax refunded, and after deducting out-payments, amounted to £39,662. 8s. 5d. against £17.507. 17s. 2d. (after similar deductions) for the corresponding period of 1888, being a difference of £22,118. 11s. 3d. in favour of the half-year under review resulting from the current tariff.

3. The working and other expenses for the same period, including income-tax, but exclusive of cost of repairs of cable, amounted to £16,626. 3s. 9d., leaving a balance of £22,950. 4s. 8d. as the net profit of the half-year, making with £11,641. 13s. 3d. brought forward from the previous half-year a total of £34,591. 17s. 11d. For the corresponding half-year of 1888 the working expenses and other payments amounted to £15,276. 11s. 10d.

4. Three quarterly interim dividends of 2s. per share for the quarter ended 30th September last, and of 3s. 6d. each per share for the quarters ended 31st December and 31st March last, amounting to £27,319. 10s. 0d. have been declared and paid during the financial year, and a final payment of 3s. 6d. per share is now proposed, making, with the three interim dividends, 3½ per cent. for the year, being a total distribution of £37,943. 15s. 0d. The balance of £2,719. 2s. 11d. on the revenue account is proposed to be carried forward.

5. The 1s. tariff continues, and the receipts have been largely increased, but a fairly remunerative revenue has not yet been attained. The traffic, however, is exhibiting signs of expansion.

6. An interruption of the main cable occurred on the 19th April last, on the "Green Bank," and was repaired on the 19th May. The cable was found to have been broken by a vessel's anchor. The cost of the repair, £4,474. 1s. 11d., has been charged to the reserve-fund account as usual. On the other hand, the sum of £7,315. 19s. 2d., being the interest and dividends received and profits realised on the sale of securities has been added thereto. The Directors do not on this occasion propose to further increase the reserve fund.

7. The appeal of the Cie Française du Télégraphe de Paris à New York referred to in the last report, was heard on the 12th, 14th and 19th March last, when the Council of the Prefecture of the Seine declared in effect that they had no right to enter into the Joint purse Agreements. An appeal to the Council of State is now pending.

8. Pursuant to the provisions of the Articles of Association, two of the Directors, viz., Admiral of the Fleet, the Hon. Sir Henry Keppel, G.C.B., D.C.L., and Admiral R. C. Mayne, C.B., M.P., retire by rotation, and being eligible offer themselves for re-election.

9. Mr. John G. Griffiths and Mr. John Sawyer, the Auditors, retire pursuant to the Articles of Association, and offer themselves for re-election.

The Edison and Swan United Electric Light Company (Limited).

The following is the sixth annual report of the Directors of this Company for the year ending 30th June last, to be presented to the general meeting of shareholders to be held at the Cannon-street Hotel, London, E.C., on Tuesday, July 30th, at twelve o'clock.

The sale of lamps and fittings has progressed in a satisfactory manner during the year, and has resulted in a credit balance of £47,729. 5s. 9d.; to this must be added the sum of £25,123 9s. 7d., the balance of account for the year ending 30th June, 1883, making a total of £72,852. 15s. 4d., out of which the Directors have appropriated the sum of £28,815. 14s. 2d. to meet losses realised on finally disposing of sundry installations taken over at the date of the amalgamation, and have, under Clause 89 of the Articles of Association, created a reserve of £4,595. 10s. 10d., and they recommend the appropriation for dividend, in accordance with Clause 87 of the Articles of Association, of 7 per cent. upon the amount paid up on the A shares, in respect of the year ended 30th June, 1889, and of 3 per cent. further on account of the arrears of preferential dividend on the A shares in respect of the year ended 30th June, 1884.

The Supply Companies are establishing central stations in London and the Provinces, which must lead to a considerable extension of the business of the Company.

The appeal of the Company from the decision of Mr. Justice Kay was heard before Lords Justices Cotton, Lindley, and Bowen, who reversed Mr. Justice Kay's judgment, and decided that Mr. Edison's patent, 10th November, 1879, was valid.

The Brush Company gave notice of their intention of appealing to the House of Lords, but a settlement has been arrived at by which the case will not be carried to the House of Lords. The Brush Company give up manufacturing incandescent lamps, and they pay the taxed costs of the action.

Viscount Anson and Mr. Ernest Villiers retire from the Board and offer themselves for re-election as Directors.

Messrs. Welton, Jones and Co. (late Messrs. Quilter, Welton and Co.), the auditors, also retire, and offer themselves for re-election.

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The Anglo-American Brush Electric Light Corporation (Limited).

The following is the report of the Directors of this Company to the shareholders, to be presented to the extraordinary general meeting to be held at the Cannon-street Hotel, on the 22nd inst., at 2 o'clock :—

The Directors announce that the Mortgage Debentures which were offered for subscription in April last have all been allotted, the applications for the same having been in excess of the amount to be allotted. As a result of obtaining this additional capital, the directors have been enabled to give effect to the policy indicated in former reports, of extending the capacity of the Corporation for carrying on its manufacturing operations ; and a provisional contract has been made to acquire the business and properties of the engineering establishment known as the Falcon Works, at Loughborough, in Leicestershire, upon the terms mentioned below.

The directors have also entered into a provisional agreement with the Australasian Electric Light, Power and Storage Company for the transfer to the Corporation of its business as a going concern. The Australasian Company, which is one of the companies formed in 1881-1882 to work the Brush and Lane-Fox patents, has also acquired by its amalgamation with the Edison Indian and Colonial Company the patent rights of Edison in India, Australasia and South Africa. The policy of re-acquiring the rights held by the subsidiary companies has already met with the full approval of the shareholders, and the terms of the proposed arrangement, which in the opinion of the Directors are fair and equitable to both companies, are mentioned below.

The Memorandum of Association of the Corporation, which was drawn up many years ago, before the present requirements of an electrical manufacturing and contracting company were realised, has been found to be inadequate. It is therefore necessary for this, as well as for a variety of minor reasons, to extend and amend the Memorandum of Association, and as this can be legally accomplished only by means of a re-constitution of the Corporation the Directors have given the whole position their very careful consideration, and now submit for the approval of the shareholders the scheme of reconstruction mentioned below.

The Directors take this opportunity of announcing the settlement of the litigation with the Edison-Swan United Electric Light Company (Limited) in regard to Incandescence Lamp Patents. Under the arrangement come to, the Edison-Swan Company accept a license to use the Lane-Fox and other Incandescence Lamp Patents held by the Corporation, and they pay the Corporation a royalty upon the basis of the number of lamps made, but subject to a maximum payment per annum. The Corporation, on the other hand, give up the manufacture of incandescence lamps, and agree to buy from the Edison-Swan Company on the most favoured terms to dealers, until the expiry of the Edison patent. The Edison-Swan Company waive all claim to damages, and it will be remembered that in regard to the Cheeseborough patent, the decision of Mr. Justice Kay was against the Corporation and no appeal was entered, but the Corporation agree to pay the Edison-Swan Company's taxed costs. The arrangement, which applies only to the United Kingdom, fully protects the Corporation's customers, who will not be subjected to any inconvenience or expense.

The only other litigation in which the Corporation is engaged is that relating to Compound Winding of Dynamos. It will be remembered that in the case against the Orient Steamship Company, which was tried in England in December last, the Brush patent for this process was upheld ; on the other hand, the action brought by Messrs. King, Brown and Co., in Scotland, for the reduction of the patent has been decided in favour of the plaintiffs. This decision is now being appealed against, but the issue will not in any way affect the manufacturing business of the Corporation.

With regard to the general business of the Corporation, the Directors are glad to be able to report very satisfactory progress. It is not practicable to specify in detail the important contracts at present on hand and in view, but it will be interesting to the shareholders to know that the orders booked during the first six months of this year equal in amount the total volume of last year's business, and when it is remembered that the past year showed a very considerable advance upon the business done in previous years, it will be admitted that the present position of the Corporation is very satisfactory, and justifies sanguine expectations in regard to the future.

The Amalgamation with the Falcon Company.—The Falcon Company was established in 1883 to take over the works and business of the Hughes Engineering Company. The capital is £60,000, divided into 50,000 Preference Shares of £1 each, and 10,000 Ordinary Shares of £1 each. The Company has, since its formation, carried on successfully the business of building locomotive and other engines, as well as tramway and other cars. For the four years ending June, 1886, the full dividend of 7 per cent. per annum was paid upon the Preference Shares ; in the following year a dividend of 2 per cent. was paid, and the dividend paid in 1888 on the Preference Shares was 5 per cent. The property consists of freehold land covering an area of over seven acres, and several buildings well adapted to the purposes of iron and brass founding, engine and car making, stores, offices, dwellings, &c., and, on the whole, the property is well adapted for the Corporation's heavy electrical work. The price to be paid for the whole of the business as a going concern is £55,000, in fully-paid shares of the new Company, and £1,000, payable half in shares and half in cash, to cover expenses incidental to the liquidation of the Falcon Company.

The Directors of the Corporation consider the arrangement very advantageous for the following, among other, reasons :—

(*a.*) Additional manufacturing works are absolutely necessary for carrying on the business of the Corporation ; (*b.*) the works of the Falcon Company are suitable for the purposes of the business ; (*c.*) the situation of the works is very convenient in respect of economy of manufacture and of conveyance of goods and materials ; (*d.*) the purchase price is to be in shares, involving no cash expenditure, except such as may be necessary for extensions and the amount mentioned above for expenses ; (*e.*) the business of the Falcon Company is carried on at a profit, and as it is proposed to continue the same, the capital expended on the purchase will not be unproductive during the period of transition necessary for the adaptation of the works to the new requirements ; (*f.*) there will be no loss of time in the acquisition of the property, and this, in view of the urgent demand for a much larger output than the Corporation is at present able to deal with, is an advantage of very great importance, and one that could not be as effectually secured by any other available means.

Amalgamation with Australasian Company.—The Australasian Company was formed in 1882 to work the Brush and Lane-Fox patents in the Australasian Colonies. The Company, as already stated, subsequently amalgamated with the Edison Indian and Colonial Electric Company, and secured the patent rights of Edison in India, Australasia and South Africa. It has also secured the sole agency under the Swan Lamp patents and other rights. The Company therefore occupies an exceptionally strong position in regard to some of the principal patents which control the more important branches of the electrical industry. Last year the Company carried out, by means of apparatus supplied by the Corporation, the important contract for lighting the Melbourne Centennial Exhibition, and altogether the Company has done important work in organising the business in the Colonies, but it has not, so far, been able to work at a profit, the volume of business having during the past years of depression been but small. The prospects now, however, have materially improved. Under the agreement with the Australasian Company hitherto in force the Corporation has been practically precluded from doing business in Australasia, except through the medium of the Australasian Company, and in the opinion of the Boards of both Companies the Corporation will, by reason of its manufacturing facilities and greater experience in the field of electrical work, be in a better position for developing the business in the Colonies than the Australasian Company. The present capital of the Company is £202,386, divided into shares of a variety of classes ; but under a scheme of reconstruction, which is now before the shareholders of that Company, it is proposed to consolidate all classes of shares, and to reduce the aggregate capital to £78,065. The price to be paid by the Corporation for the transfer of the business as a going concern is £45,000, payable in fully-paid shares of the Corporation or of the re-constituted Brush Company, as mentioned below, and £1,000 payable half in shares and half in cash to cover the expenses of winding up.

Scheme of Reconstruction.—It is proposed to transfer all the assets and liabilities of the Anglo-American Brush Electric Light Corporation to a new Company to be registered under the title of the Brush Electrical Engineering Company (Limited), with extended Memorandum and Articles of Association. The present subscribed capital of the Corporation is 52,314 shares of £5 each = £261,570. (Of these 25,803 shares are £5 fully paid up and 25,511 are £5 each with £4 per share called up.) The capital of the new Company is to be £750,000, divided as follows :—£300,000 in 150,000 Six per cent. Preference Shares of £2 each, £450,000 in 150,000 Ordinary Shares of £3 each.

The proposal is, that the shareholders of the Corporation shall receive in respect of each £5 fully paid share held by them one Preference Share of £2 and one Ordinary Share of £3 in the new Company ; that the Falcon Company shall receive £55,500 in 11,500 Preference Shares of £2 each and 11,100 Ordinary Shares of £3 each ; and that the Australasian Company shall receive £45,509, in 9,100 Preference Shares of £2 each and 9,100 Ordinary Shares of £3 each.

The arrangement will involve the voluntary liquidation of the Anglo-American Brush Electric Light Corporation, and in view of the desirability of removing the distinction at present existing between the partly-paid and the fully-paid shares, by which the market value of the shares is affected, it is proposed that the liquidators should call up the £1 per share remaining unpaid on 25,511 shares.

It will be necessary to obtain the sanction of the debenture holders to the scheme, but as it is proposed to issue debentures of the new Company of equal amount to, and on the same terms as, the present issue, the debenture holders will in view of their security being materially increased by the accession of the assets of the Falcon and Australasian Companies have every reason for acceding to the arrangement.

DISTRIBUTION OF CAPITAL.

—	Debentures.	6 per Cent. Preference Shares.	Ordinary shares.	Total. Debentures.	Total. Shares.
	£	£	£	£	£
To be issued to debenture holders of Brush Corporation.....	75,000	...	...	75,000	...
To be issued to present shareholders of Brush Corporation	...	104,628	156,942	...	261,570
To be issued to Falcon Company	...	22,200	33,300	...	55,500
To be issued to Australasian Company	...	18,200	27,300	...	45,500
	75,000	145,028	217,542	75,000	362,570
Balance unissued..	...	154,972	232,458	...	387,430
	...	300,000	450,000	75,000	750,000

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The share and debenture capital account of the new Company will stand thus :—

Nominal share capital	£750,000
Mortgage debentures	75,000

The Directors are advised that the subdivision of the capital in the way proposed will tend to appreciably improve its market value, and the numerous precedents for this course afforded by the large railway and other companies strongly support this view. It is obvious that as a result of this proposed subdivision of the capital the shareholders will have much greater certainty of receiving satisfactory dividends upon at least a portion of their holdings than if the profits of the business had to be distributed over the whole of the capital alike.

In conclusion, the Directors are of opinion that the present is a very favourable opportunity for carrying out a scheme of this nature, which has been under their consideration for some time past, but which, owing to the late unfavourable condition of the industry, and to the want of adequate working capital necessary for effecting the enlargement of the works, has not been practicable before. After a long period of depression, the business has now entered upon a new and more encouraging phase, and by taking energetic steps to cope with the increasing demand for electrical work of every kind, the Company will, it is confidently believed, forthwith place itself in a dividend-paying position. The character and the amount of the work now carried on by the Corporation and the prospects of future business are such that the Directors see no reason why the new Company should not, from the date of its registration, earn sufficient profits to admit of regular dividends being paid from the outset. The Board are of the opinion that the opportunity of the reconstruction should be taken to strengthen the Directorate. They propose to offer seats at the Board to one Director of the Falcon Company and one Director of the Australasian Company, and they are in consultation with some of the leading shareholders as to the advisability of appointing one or more additional Directors. The Directors further refer to the notice convening a special meeting of the shareholders and the resolutions set out, and they strongly recommend these resolutions for adoption in the full conviction that the course suggested will be found to be in every respect beneficial to the shareholders.

The folowing are the resolutions referred to :—

Resolution No. 1.—"*That the Provisional Agreement entered into between the Corporation and the Australasian Electric Light Power and Storage Company (Limited), dated the 12th day of July, 1889, and submitted to the meeting be, and the same is hereby sanctioned, adopted, and confirmed, and that the Directors be authorised to carry the same into effect with or without modifications.*"

Resolution No. 2.—"*That in accordance with the terms of the Agreement mentioned in the above resolution, the Directors shall, if necessary, issue to the Liquidators of the Australasian Electric Light Power and Storage Company (Limited), or to such persons and in such manner as the Liquidators shall in writing direct, fully paid £5 shares in the capital of the Corporation not exceeding 9,100 in the aggregate.*"

Resolution No. 3.—"*That it is desirable to reconstruct the Anglo-American Brush Electric Light Corporation (Limited), and that with a view thereto the Corporation be wound up voluntarily, and that J. B. Braithwaite, Junr., and E. Garcke, be, and they are hereby, appointed Liquidators for the purposes of such winding up.*"

Resolution No. 4.—"*That the said Liquidators be, and they are hereby, authorised to consent if required to the registration of a new Company to be named 'The Brush Electrical Engineering Company (Limited),' with a Memorandum and Articles of Association which have already been prepared with the approval of the Directors of the Corporation, but which are to be subject to such alterations and modifications, if any, as may be found expedient.*"

Resolution No. 5.—"*That the Draft Agreement submitted to this Meeting and initialled by the Chairman for the transfer of the business and property of this Corporation to the new Company shall be and the same is hereby approved, and that pursuant to Section 161 of the Companies Act, 1862, the Liquidators shall be, and they are hereby, authorised to enter into an Agreement with such new Company (when incorporated) in the terms of the said draft, and generally to carry the same into effect with such (if any) modifications as the Liquidators may find expedient.*"

Should resolutions 3, 4, and 5 be passed either with or without modification by the required majority, they will be submitted for confirmation as special resolutions to an extraordinary meeting which will be subsequently convened.

In reference to the amalgamation referred to above, the following is an abstract of a circular sent to the shareholders of the

Australasian Electric Light, Power and Storage Company (Limited).

"I am instructed to inform you that the Directors have entered into negotiations with the Anglo-American Brush Electric Light Corporation, with a view to amalgamation with that Company. . . . .

Your Directors have, therefore, felt justified, in the interests of all classes of the shareholders, in abandoning the scheme for reduction of capital and the issue of preference shares proposed in the circular of 23rd January last, and have entered into an agreement, subject, of course, to the approval of the shareholders, by which the new Brush Company will take over the entire business of the Australasian Company, including all liabilities and assets, as hereinafter explained.

The consideration to be paid by the new Company is a sum of £45,000 in preference and ordinary shares, which will be available for distribution among the shareholders, inasmuch as the Brush Company, in addition thereto, pays expenses of liquidation. As it is not possible to speak with absolute accuracy of the position and liabilities at the present moment in Australia, it has been necessary to provide for the possibility of a reduction of this amount in the event of unforeseen liabilities appearing, or in the event of any of the patents having lapsed ; but the Directors have taken all practical precautions on these points, and do not anticipate any material modification under this head.

The shares of the Anglo-American Company at present are of the denomination of £5 each, some fully paid and others £4 paid, but the unpaid portion on these latter will now be called up for the purpose of equalisation. These £5 shares are quoted 4¼ ¾, and it is now proposed, in the amalgamation, to make two classes of shares, the present £5 share being represented by one preference share of £2 entitled to 6 per cent., and one ordinary share of £3 entitled to the residue of all the profits.

As in the case of the Anglo-American Company, it will be necessary that the 10s. per share now remaining due upon a certain number of the shares of the Australasian Company should be called up for the purpose of equalisation.

According to the Articles of Association of the Australasian Company the sum of £45,000 would be divisible in the following proportions between the original ordinary and the ordinary (Edison) shares, viz. : — The original ordinary £5 shares will be entitled when fully paid up to £39,815, equal to about £1. 10s. 3d. per share. And the ordinary (Edison) £1 shares (already fully paid), being only entitled to rank for 50 per cent. of their face value in any distribution of assets, will be entitled to £5,185, equal to about 3s. 1d. per £1 share.

PATENT

SILICIUM BRONZE AND SILICIUM COPPER WIRE.

The best for overhead Telephone and Telegraph Lines,

AND ALL ELECTRICAL PURPOSES.

Hard Drawn High Conductivity Copper Wire.

ROLLED AND DRAWN

PHOSPHOR BRONZE.

PHOSPHOR BRONZE

BEARINGS, BUSHES,

AND OTHER PARTS OF

ELECTRICAL MACHINERY.

SOLE PROPRIETORS of the British, Indian and Colonial Patents,

THE PHOSPHOR BRONZE COMPANY (Limited),

87, Sumner Street, Southwark, London, S.E.

WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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The Directors anticipate that the shareholders will reap considerable advantage from the much better quotation and freer market which it may be expected the shares of the Brush Electrical Engineering Company will enjoy than is possible, in the circumstances, with the shares of the Australasian Company. . . . .

By order of the Board,
J. H. DUNCAN, Secretary."

"Dear Sir,—An extraordinary general meeting of the shareholders in this Company will be held at the offices of the Company, No. 39, Coleman-street, in the City of London, on Tuesday, the 23rd inst., at 3:30 o'clock, for the purpose of considering a proposed sale of the property and assets of the Company to the Anglo-American Brush Electric Light Corporation, (Limited), and in the event of the proposed sale being approved by the shareholders, the following extraordinary resolutions will be proposed to be passed :—

Resolution No. 1.—'*It is hereby resolved to adopt, ratify and confirm the Agreement, dated the 12th day of July*, 1889, *and made between the Australasian Electric Light, Power and Storage Company, of the one part, and The Anglo-American Brush Electric Light Corporation (Limited), of the other part; and the Directors are hereby authorised and requested to do all things that may be necessary for the purpose of giving effect to the said Agreement, and carrying out the provisions thereof, either with or without modification.*'

Resolution No. 2.—'*That the Company be wound up voluntarily, and that Mr. John Henry Hill Duncan, of 39, Coleman-street, in the City of London, Chartered Accountant, and Mr. Emile Garcke, of Belvedere-road, Lambeth, be and they are hereby appointed joint Liquidators of the Company upon the terms specified in the above agreement of the 12th day of July instant, and with instructions to carry the said agreement into effect, with or without modifications approved by the Directors.*'"

Exeter Electric Light Company.

The first meeting of this Company will be held next week. The Directors report that numerous obstacles had been raised which greatly retarded the introduction of the electric light into the city, but they had persevered in their efforts, and they have now succeeded in overcoming difficulties which at one time appeared almost unsurmountable. A central depôt has been purchased in New North-road, close to the railway. After referring to the accounts, the Directors state that the demand for electric lighting in Exeter has more than realised their expectations. Already a large number of arc lamps and about 1,000 incandescent lamps have been applied for. Contracts have been entered into for lighting several public buildings and places of worship, and some of the most enterprising citizens, including the proprietor of two of the principal hotels, have decided to light their premises with the electric light. The Taunton Electric Light Company (Limited), which was formed upon a similar basis to the Exeter Company, and which employs the same system, paid 5 per cent. the first year and 6 per cent. the second year, besides carrying forward a considerable sum for reserve and depreciation, and this year it is expected that a dividend of not less than 7 per cent. will be earned. The Directors see no reason to doubt that results equally satisfactory will be achieved in Exeter. The share capital already subscribed, including shares agreed to be taken, amounts to £7,000.

NEW COMPANIES REGISTERED.

THE ECUADOR TELEPHONE COMPANY (LIMITED).—Registered by Slaughter and May, 18, Austinfriars, E.C., with a capital of £100,000 in £5 shares. Object—to carry into effect an agreement made between W. A. Pittman and the Ecuador Telephone Company (Limited), to acquire any lines of telegraphs, telephones, or other means of communication in Ecuador. There shall not be less than three nor more than seven directors. Qualification, £1,000 stock. Remuneration to be determined in general meeting.

THE WESTINGHOUSE ELECTRIC COMPANY (LIMITED).—Registered by Norton, Rose, Norton and Co., with a capital of £600,000 in £10 shares. Object, to acquire certain patents, goodwill, business, inventions, machinery and property of the American company, known as the Westinghouse Electric Company; to carry on the business of makers and suppliers of and dealers in electricity, electric power and light, to create, produce, store, accumulate, supply, hire, and lease electricity, electric power or other similar agency for any purpose; to acquire all land, estates, factories, personal property, rights, and privileges requisite or convenient for the purposes of the company whether from the Westinghouse Electric Company in America or elsewhere. The first subscribers are:—Sir H. W. Tyler, M.P., Pymms-park, Edmonton; F. Parg, Foley House, Portland-place; J. D. Gibbs, 18, Warwick-street, Regent-street; C. C. Macrae, 20, Cheyne-walk, Chelsea; W. D'Oyley, 24, Westbourne-terrace, W.; H. T. Norton, 57½, Old Broad-street; H. R. Laing, 3, Drapers'-gardens, E.C. There shall not be less than three, nor more than 12 directors. Qualification, 100 shares. The first are F. Parg, Sir H. Tyler, J. D. Gibbs, G. Westinghouse, jun., and J. Humbard, the last two not joining the board till after completion of purchase. Remuneration, £2,000 per annum, divisible as they agree.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—At a meeting of the Board of Directors of this Company held on Monday last, it was resolved to declare an interim dividend for the quarter ended 30th June last, of 15s. per cent. on the Ordinary Stock, and £1. 10s. per cent. on the Preferred Stock, less income tax, payable on the 1st August to the stockholders registered on the books of the Company on the 10th July, 1889.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended July 12, 1889, amounted to £4,150.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—At a meeting of the board of directors of this Company, held on Friday, it was resolved to recommend a final dividend of 3s. 6d. per share, free of income tax, payable on and after the 27th inst., making, with the interim dividends already paid, 3⅛ per cent. for the year ending 30th June last, carrying forward a balance of £2,719 2s. 11d. The register of transfers will be closed from the 12th to the 26th July, both days inclusive.

THE DIRECT SPANISH TELEGRAPH COMPANY.—This company will remove to their new station, No. 74, Gracechurch-street, during the night of Friday, the 19th inst. The whole building, which is fitted up in the most complete manner for the purpose, has been occupied by the telegraph department of the company. The station works direct with Bilbao (875 miles) and with Madrid by translators at Bilbao (1,190 miles). It has also communication by pneumatic tube with the General Post Office in St. Martin's-le Grand. In order to adapt the building to the requirements of the company extensive alterations have been made, the architect being Mr. A. E. Thompson, of Leadenhall-buildings, and the contractor Mr. A. Porter, of Tottenham. The comfort of the staff and the sanitary arrangements have been particularly attended to, the whole of the drains having been arranged in the most improved manner.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—This company announce that the coupon on the Six per Cent. Debentures, due August 1, will be paid on and after that date at the Consolidated Bank, Theadneedle-street, E.C.

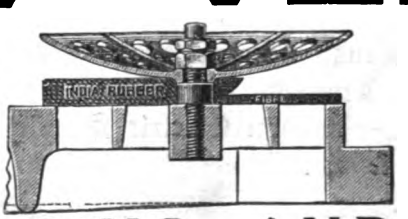
GLOBE TELEGRAPH AND TRUST COMPANY.—This company announces a balance dividend of 4s. per share, making a total of 4⅛ per cent. for the year ending the 18th inst., carrying forward £2,043.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 12, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,793.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this company for the half-month ended July 15, 1889, amounted to £2,519, as compared with £2,544 for the corresponding period last year. The March receipts, estimated at £7,394, realised £7,37[illegible].

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, July 17, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 17, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	2½%	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	54	53⅞
2,614,820	Stock	5%	Do. Preferred	90 91	4 7 0	,, ,,	91⅝	90⅞
2,614,820	Stock	...	Do. Deferred	18½ 19	...	February	18⅞	...
190,000	£10	10%	Brazilian Submarine	13 13½	5 3 8	Mar., June, Oct., Dec.	13⅝	13¼
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	..	...
16,000	10	9%	Cuba Submarine	14⅜ 15½	5 18 0	February and August	15½	14⅞
6,000	10	10%	Do. Preference 10%	19½ 20½	4 17 7	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅞ 4¼	4 4 8	March & September	...	...
6,000	5	10%	Do. Preference 10%	8½ 9¼	5 5 3	April and October	...	.
60,710	20	3½%	Direct United States	10⅜ 11	5 0 0	Jan., Apr., July, Oct.	10⅛	10⅞
380,000	10	5%	Eastern	13⅜ 13⅝	4 15 7	,, ,,	13⅞	13½
70,000	10	6%	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	15	...
1,200,000	Stock	4%	Do 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109¼	108
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	4 10 1	February & August	..	...
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	104 106	5 13 2	February & August	106	104¾
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	104¼	...
179,177	10	6%	Globe Telegraph and Trust	8⅜ 8⅝	4 15 9	Jan., Apr., July, Oct.	8⅝	8½
178,992	10	6%	Do. 6 per Cent Preference	14⅞ 15¼	3 19 4	,, ,,	15⅛	14⅞
150,000	10	7½% for '88	Great Northern	15¼ 15⅝	4 12 4	Jan., July, and April	15⅝	15¼
17,000	25	15%	Indo-European	39 41	6 1 11	April and October	...	...
9,000	8	5%	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	104	...
30,000	10	6% for '88	West Coast of America	10 10½	..	January and July	10½	10 1/16
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	124	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2½	2⅜
34,563	10	12/0*	Do. 1st Preference 6%	11¾ 12¼	...	April and October	12	...
4,669	10	†	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	6%	Western Brazilian	11 11½	6 10 4	March & September	11 3/16	11 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	116½	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,350	14/0	7%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	⅞	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	4 8 3	...	...	...
80,000	5	25%	United	15 15½	5 12 11	June and December	15⅝	15⅛
55,000	5	3/0	United River Plate	6 6½	...	January and July	6 5/16	6¼
			ELECTRIC LIGHT.					
23,003	5	..	Anglo-American Brush (£4 paid)	3½ 4	...	...	3⅝	...
23,692	5	...	Do. (fully paid)	4¼ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	4⅜ 4⅝	...	...	4⅝	4 5/16
			MISCELLANEOUS.					
37,350	12	30/0	Telegraph Construction and Maintenance	42 44	5 6 3	March and July	43½	42¾
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19½	19¼

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
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MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 584.—Vol. XXIII. FRIDAY, JULY 26, 1889. Price Fourpence.

NOTES.

We publish this week a second article from the pen of Dr. S. Doubrava upon the distribution of high-tension continuous currents with transformation by means of condensers. Notwithstanding the well-recognised advantages of a practicable system of continuous-current transformation, no one, so far as we are aware, has hitherto thought it worth while seriously to to investigate the inherent capability of the condenser, the difficulties in the way of affecting the necessary reversals being at first sight insuperable. Yet this difficulty has been overcome by Dr. Doubrava in the simplest and most effective way. It is simply a question of causing the commutator to synchronise with the natural period of the condenser when charged under constant E.M.F. A moment's consideration will show that if a disconnection is effected *at the moment when the condenser is fully charged* there is no difference of potential at the points of separation, and consequently no possibility of sparking. The whole system, which is very ingeniously worked out, depends, therefore, upon the speed of the commutator synchronising with the period of charge and dischgare of the condenser. At present Dr. Doubrava proposes to have only one commutator, which is placed at the generating station, or, if preferred, at a sub-distributing station. This arrangement avoids the difficulties of synchronising so long as all the condensers are of the same capacity; but, on the other hand, as we shall then have an intermittent current in the mains or sub-mains, the special advantages of the continuous current are abandoned. At present we fear that Dr. Doubrava's system is more interesting and ingenious than it is practica.

According to the original programme of the promoters of the Paris Exhibition it was proposed to institute a series of exhaustive tests upon electrical apparatus similar to those carried out in previous years, at Paris in 1881, at the Crystal Palace, at Vienna, Munich, Philadelphia, and Antwerp. This intention has, however, been allowed to fall through, and the building which was originally intended to enshrine a magnificent laboratory of electrical engineering was at an early stage assigned to meaner uses. Whether or not this should form a subject for serious lamentation is a question upon which there may easily be more opinions than one. In the earlier days of the industry accurate and reliable data of the performance of dynamos, motors, lamps, and accumulators, were urgently required, and we are deeply indebted to the promoters of the Exhibitions which have just been enumerated for furnishing the opportunity to obtain such statistics, whilst we are still more indebted to those by whom the elaborate tests were so ably carried out. It must, nevertheless, be recognised that such experiments as it is possible to execute upon these occasions, however skilfully they may be designed and conscientiously executed, cannot possibly take into consideration every circumstance which determines the relative commercial value of the apparatus experimented upon. For our own part we are strongly of opinion that *as a general rule* it would be fairer and more useful—as well as less invidious—to institute a *pass* rather than a *competitive* examination in these cases. Let the Committee draw up certain conditions (the degree of stringency of which would of course be in each case a subject for the most careful consideration), and let them then content themselves with issuing certificates to all firms whose apparatus is found to fulfil the required conditions without assuming the responsibility of affirming that A's apparatus is superior to either B's or C's. An effective examination of this kind could be carried out in less time and with infinitely greater certainty than the present system will admit, whilst we have little doubt that the results would give far greater satisfaction to exhibitors in general, and would infallibly lead to a large increase in their numbers. As an additional advantage it might easily be arranged that upon the application of any individual exhibitor the exact figures recording the performance of his apparatus should be issued under the certificate of the Committee.

We do not know, nor are we much concerned to inquire, whether the suggestion made in the above paragraph is or is not original; but we do venture strongly to recommend it to the serious consideration of all who are responsible for the conduct of Exhibitions, at least where electrical apparatus is concerned. Especially do we urge it upon the consideration of the Executive Committees of the forthcoming Exhibition at Birmingham and that to be held next year in Edinburgh. The principle may not be applicable in all cases, but as regards at least the most important appliances of electrical engineering, its successful enforcement would, we imagine, present no very serious difficulty.

At Paris, as we have intimated above, it is not at present intended to carry out any electrical tests whatever.

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Medals and Certificates are to be awarded to the exhibitors at the discretion of the Committee, and will therefore be taken for just what they may be supposed to be worth. It is, however, worthy of note that without exception all the more prominent firms of electrical engineers of French nationality have already placed themselves out of the running, and are declared "*hors concours*" by reason of their having one or more representatives upon the Executive Committee. The spoils will, therefore, be divided betwixt America, Switzerland, and Belgium, with perchance a scanty tribute to this country, though we take it that the chief of the small array of English exhibitors are likewise *hors concours*.

We understand that the Metropolitan Telephone Service has now been handed over from the United to the National Telephone Company, and the officers of the latter company are engaged in making a thorough investigation into the existing state of affairs. That they will discover magnificent opportunities for effecting improvements in the service we do not doubt in the least, and we shall be greatly disappointed if the highly successful results attained in Manchester, Glasgow and Dundee are not eventually reproduced in London in spite of the confessedly greater difficulties of the undertaking. Meanwhile, in common fairness to the technical staff of the late United Company, it must be remembered that their efforts have from the first been hampered by a policy which has now been overturned; indeed, no fair opportunity of dealing with the problem has ever been afforded them.

After devoting four sittings last week to the consideration of the Metropolitan Electric Lighting schemes, the Parliamentary Select Committee concluded its labours on Friday, confirming the several Provisional Orders and agreeing on a report to the House. Stringent rules have been introduced with regard to the Companies' accounts, which are to be audited by the Board of Trade, and also a distinct prohibition of amalgamation or association except with the sanction of Parliament. Reciprocal arrangements were agreed to between the Gas Companies and the Water Companies on the one hand, and the Electric Companies on the other, with reference to the digging of trenches, so as to mutually safeguard their property underground. These provisions are not likely to be disturbed in Parliament, where the Bills are down for third reading this week.

The sectarian squabble over the Technical Education Bill has resulted, as we last week feared it would, in its virtual withdrawal, the Government confessing their inability to meet the wishes of the two conflicting parties by any compromise that would be agreeable to both. Mr. W. H. Smith has promised a measure this session dealing with "higher" technical education—meaning apparently that, for the present, elementary schools are not to be assisted at all in that direction. The new Bill was read a first time on Wednesday.

It was, we suppose, inevitable that as soon as the electrical purification of sewage had been shown by Mr. Webster to be commercially feasible it would be discovered that there were several possible ways of purifying sewage by electricity. A discovery of this description has apparently been made by M. Hermite, of electric bleaching fame, whose modification of the Webster process is now being tried on a large scale at Rouen. Where sea-water is available M. Hermite proposes to pump it into an "electrolyser," and after converting it therein into a powerful disinfectant it is to be used in lieu of fresh water to flush the drains and water the roads. The cost of chemicals is, of course, in this method *nil*, though since it involves, if thoroughly carried out, the laying of a duplicate set of mains, the first cost is likely to act as a strong deterrent. In inland towns M. Hermite's process merely consists in passing the town sewage through a battery of "electrolysers" containing common sea salt, from one to five kilogrammes of which, he estimates, will be required per cubic metre of liquid (say, from 70 to 350 grains per gallon), so that on a moderate reckoning the Hermite process must be several times more costly than that of Mr. Webster. When we add that M. Hermite employs anodes of platinum and kathodes of zinc, and in lieu of simply passing the effluent through an inclined shoot, maintains the circulation of the liquid by means of a turbine, it will be evident that the modified process is scarcely an improvement on the original.

The alternator designed by Mr. C. F. Brush and Mr. G. Pfaunkuche for the American Brush Company (of which a further account will be found in the letter of our New York correspondent) may be briefly described as a Mordey armature set in a revolving field of the Siemens' alternate pole type. The machine is designed for 110 alternations, with 2,000 volts terminal pressure. The transformer is chiefly noteworthy from the fact that simplicity of design and construction has been to some extent sacrificed with a view to obtaining high efficiency over a large range of output.

Electric Lighting in Australia.—Steps are being taken both at Newcastle (New South Wales) and Fitzroy (Victoria) to have the streets lighted by electricity.

Blackrod.—An Electric Lighting Company have notified their intention of applying for a Provisional Order to supply electricity in the Blackrod Board's district.

Gloucester.—At the last quarterly meeting of the City Council it was announced that several electric light companies had made proposals for lighting the city by electricity.

Milnrow.—The Lancashire and Cheshire Electric Light Company have given notice of their intention to apply for powers to introduce the electric light into the Milnrow district.

Malvern.—The Birmingham House-to-House Electricity Company have given notice that they intend applying for a Provisional Order to supply electricity in the Malvern district.

The Obock-Perim Cable.—The cable between the Island of Perim and the French colony of Obock has been successfully laid by the Eastern Telegraph Company, and is now working.

Horwich.—The Local Board has received a notice from the Lancashire and Cheshire House-to-House Electricity Company intimating that they intend to apply for a Provisional Order.

Edmonton.—Notice has been served on the Local Board by the House-to-House Electric Light Supply Company of their intention to apply to the Board of Trade for a Provisional Order.

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The Telegraph in China.—The telegraph line across China from Shanghai and other ports to Momein or Tengyueh, which is about 100 miles from Bhamo, has been completed within the last few weeks.

Stroud.—At a recent meeting of the Stroud Board of Health the Clerk read a communication from the Western House-to-House Electricity Company giving notice that they intended to apply for a Provisional Order.

Melton Mowbray.—At the last meeting of the Melton Mowbray Local Board the Clerk read a letter from the Midland House-to-House Electricity Company, stating that they intended to apply for a Provisional Order.

Maindee.—At a recent meeting of the Christchurch Local Board, a letter was read from the House-to-House Company announcing their intention of applying for a Provisional Order to light the Maindee district by electricity.

Stafford.—The Midland House-to-House Electricity Company have served the Stafford Town Council with notice that they intend to apply for a Provisional Order. The matter was referred to the General Purposes Committee.

Stourbridge.—At the last meeting of the Town Council a notice was read from two electric lighting companies of their intention to apply to the Board of Trade for powers to supply the inhabitants of this town with electric light.

Fareham.—At a public meeting of the ratepayers of Fareham last week it was decided to reject the offer of the Gas Company to sell the gasworks to the town, and to invite tenders for lighting the parish with "gas, oil, or otherwise."

Chiswick.—At a recent meeting of the Chiswick Local Board the Clerk read a notice from the House-to-House Electric Light Supply Company of their intention to apply for a Provisional Order. It was referred to the Works Committee to report.

Moss Side Local Board.—At a meeting of the General Purposes Committee the assent of the Board was given to the proposal of the Manchester House-to-House Electricity Company to supply electricity for public and private purposes within the Board's district.

Gillingham.—At the last meeting of this Board notice was received from the Municipal Electric Light and Power Company of their intention to apply to the Board of Trade for a Provisional Order for power to supply the electric light in the Board's district.

Nuneaton Local Board.—At the last meeting of this Board the Clerk read a communication from the Midland House-to-House Electricity Company, giving notice of their intention to apply for a Provisional Order, and asking the consent of the Board to the application.

Lightning.—There are grounds for believing, says the *Centralblatt*, that the blue lightning flashes are the most powerful, but do not cause fire, whereas those of a reddish colour are less in power but do cause ignition. What the grounds *are* is not stated.

Oldbury.—At a recent meeting of the Oldbury Local Board of Health the Clerk reported that he had received a notice from the Midland House-to-House Electricity Company, intimating their intention to apply for powers to supply electricity within the Oldbury Local Board District.

Twickenham.—Notices of intention to apply for Provisional Orders for Twickenham have been received from the South-Western District of the Thames Valley Electricity Supply Company, the South of England Electricity Company, and the Counties Electricity Supply Corporation.

Clee Local Board.—At the last monthly meeting of this Board a communication was read from the Midland House-to-House Electricity Company, intimating their intention to apply for a Provisional Order to authorise the employment of electricity within the district of Clee-with-Weelsby.

Stonehouse.—At a recent meeting of the Stonehouse Local Board the Clerk read a notice from the Devon and Cornwall Electricity Supply Company, stating that it was their intention to apply for a Provisional Order. The application was granted subject to the plans of the company being in accord with the bye-laws of the Board.

Shrewsbury.—At a recent meeting of the Shrewsbury Town Council a notice was received from the Midland House-to-House Electricity Company to the effect that they intended to apply for a Provisional Order. A similar notice was also received from Crompton and Co. The matter was referred to the Gas, Water, and Lighting Committee.

Reading.—At the last meeting of the Town Council the Town Clerk submitted notices received by him of intention to apply to the Board of Trade for Provisional Orders, namely, from the South of England House-to-House Electricity Company, from the Electric Construction and Maintenance Company, and from the promoters of a company intended to be formed.

Arbroath.—At a meeting of the Corporation, held on Tuesday last week, the Clerk submitted an intimation by the Scottish House-to-House Electricity Company to the effect that the Company intended to apply for a Provisional Order, and soliciting the consent of the Corporation to the application. The application was remitted to the Committee of Management to consider and report.

Preserving Milk by Electricity.—M. Maisonhaute, says the *Bulletin International de l'Electricité*, having noticed that the passage of a current of electricity through milk retarded the formation of cream, made a series of experiments to see whether milk could be kept fresh in this manner. The result of these experiments is a patent for the preservation of milk by means of either static or current electricity.

Genoa.—The work in connection with the electric lighting of the principal streets and squares of Genoa is now approaching completion. The lighting will be effected by 108 12-ampere arcs, arranged on three circuits, each 5 kilometres long. The conductors are all of electrolytic copper, 3·5 millimetres in diameter, and are run overhead. The contractor, M. Albert Preve, has obtained the concession for the public lighting only for five years.

The New Companies.—According to a table just published by the *Investors' Guardian*, the capital of the electrical companies registered during the first six months of 1889 amounted to £3,563,600, as against £2,254,000 and £1,047,000 for the first six months of 1888 and 1887 respectively. The above figures do not include the registered capital of new telephone companies, which amounted during the first six months of the present year to £250,000.

Salford.—The application of the Manchester House-to-House Electricity Company for the consent of the Town Council to their electric-lighting schemes has been considered by the Parliamentary Sub-Committee of the Salford Council. The Committee have decided to recommend the Council to oppose this scheme, and secondly, to apply under the Electric Lighting Acts for powers enabling the Council to supply electricity for lighting purposes within the borough.

Maidstone.—The Maidstone Gas Company has refused to accede to the petition of the local authorities to reduce the price of their gas for public lighting, and consequently the Local Board have appointed a committee to consider the proposals of the Municipal Electric Light and Power Corporation, the Electric Construction and Maintenance Company, and the South of England House-to-House Electricity Company, who have given notice of intended application for Provisional Orders.

"The Electrician" Dinner.—The annual dinner of the proprietors and staff of *The Electrician* Printing and Publishing Company took place on Monday last. Last year's visit having proved a success, the party again went to Ightham, near Sevenoaks, where a pleasant day was spent, the weather being fine and agreeable. Dinner was provided at the "George and Dragon," where, soon after three o'clock, about 70 guests sat down, Sir John Pender, K.C.M.G., presiding, supported by Sir James Anderson.

Withington.—At a recent meeting of the Withington Local Board communications were received from the Anglo-American Brush Electric Light Corporation and the Manchester House-to-House Electricity Company, informing the Board that it was their intention to apply for Provisional Orders for the lighting of Withington. The Clerk was instructed to reply that while

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the Board was not opposed to the introduction of the electric light, they could not at once consent to the applications, and asked for further particulars.

Johnstone.—At the last monthly meeting of the Johnstone Town Council a letter was read from the secretary of the Scottish House to-House Electricity Company, asking the consent of the local authority to an application to the Board of Trade for a Provisional Order to supply electricity to the town. It was agreed to refuse consent. A special meeting of the Town Council was decided upon to take the whole question into consideration as to the propriety of making application for power to provide electricity so far as they may be requested to do so.

Electric Tramways in Australia.—The Sandhurst and Eaglehawk Electric Tramway Company (Limited), formed for the purpose of putting down a tramway and working it electrically, have entrusted the work to Messrs. Booth, Ellson and Co., electrical engineers, of Melbourne, who have placed the order for the plant for the charging station with the Anglo-American Brush Electric Light Corporation (Limited), who will also supply the cars, motors, and accumulators. It is expected that the first section of the work—a line five miles in length—will very shortly be in operation.

Falmouth.—At a recent meeting of the Falmouth Urban Sanitary Authority, a letter was read from the Falmouth Gas, Coal and Coke Company, stating that, subject to the approval of the shareholders, the directors intended to apply for the necessary license and authority to supply the Authority's district with electricity. The Clerk then read similar applications from the Devon and Cornwall Electricity Supply Company and the Electric Construction and Maintenance Company. It was decided that the letters be acknowledged, and that they be considered at the next meeting.

A Locomotive in Motion Struck by Lightning.—The remarkable incident of an express train being struck by lightning while moving at the rate of thirty miles an hour recently occurred, says the *Scientific American*, on the New York and New Haven Railway, at Stamford, Ct., durmg a heavy thunderstorm. It was shortly before four p.m., as the train was whirling through the town, that a tremendous flash of lightning struck the centre of the locomotive. Both the driver and fireman were half stunned, and the engine was so disabled that another one had to be substituted.

Southampton.—At the last meeting of the Town Council, Messrs. Sharp, Harrison, Turner and Turner wrote, giving notice that the Southampton Electric Lighting and Power Company proposed to make application for a Provisional Order. There was also a similar notice from the Electric Construction Company and a further notice from the South of England House-to-House Electricity Company. The first letter was referred to the Special and General Works Committee, but the Council did not think it desirable to refer the other letter to Committee, already having entered into an arrangement with the first-mentioned company.

Cambridge.—At the last meeting of the Cambridge Improvement Commissioners notices were served upon the Clerk of the intention of the undermentioned companies to apply for Provisional Orders for supplying electricity within the district of the authority:—The Cambridge University and Town Electric Lighting Company, the Electric Trust, the Midland House-to-House Electricity Company, and the Electric Construction and Maintenance Company. It was agreed that the matter should be referred to the Paving, Drainage, and Lighting Committee, and that they should also inquire whether it was desirable that the local authority should take it in hand themselves.

Hove.—At a recent meeting of the Works and Improvements Committee of the Hove Commissioners, the Town Clerk reported the receipt of notices of intention to apply for Provisional Orders from the Brighton and Hove Electric Lighting Company, the Electric Construction and Maintenance Company, and one on behalf of a Company yet to be formed. It was decided that the Town Clerk should be instructed to place himself in communication with Messrs. Sharpe, Parker, and Co., parliamentary agents, in order that proceedings might be taken for obtaining for the Commissioners a License or Provisional Order, as may be advised, for the supply of electricity within the town of Hove.

The Inspection of Electrical Installations on Board Men of War.—An order has just been issued by the Admiralty to the effect that the electrical fittings of all ships are to be inspected and tested by the Steam Reserve and Dockyard officials as soon as a ship is commissioned. This is to be done in the presence of officers from the Departments of the Directors of Naval Ordnance and Construction, and also of the officers and men of the ships, in order that they may see everything is in perfect order and become familiar with the electric installation worked at its full power by the Dockyard and Steam Reserve officials, and to prevent any subsequent conflict of opinion in case of any mishap when on actual service.

The Barking-road Electric Cars.—On Monday evening last a defective driving-switch on one of the Barking-road cars short-circuited the battery of accumulators (100 volts) just as the driver, after putting down the passengers at Green Gate, Plaistow, was taking the car on to the stand previous to leaving for Canning Town. The instantaneous combustion of the insulation of the cable and evolution of gases from the passage of so great a current produced an explosion which lifted the seats and shattered the glass of all the windows on each side of the car. No damage was done to the electrical equipment, save the destruction of the insulation of 20ft. of 19/18 cable, as it was protected by suitable cut-outs.

Mansion Lighting.—Messrs. Drake and Gorham have at present several orders for house lighting on hand, amongst which is the new mansion now being built for B. Freeman Mitford, Esq., where there will be 300 lights in all, supplied by two 8 horse-power Marshall engines and two 10 horse-power Cornish boilers. The same firm are also fitting Alnwick Castle, the Duke of Northumberland's seat, with the electric light. The power is to be obtained from the river by means of a turbine placed half a mile from the castle. This will drive an Elwell-Parker dynamo of 18 units capacity for the charging of accumulators placed in one of the outbuildings of the castle. There will be upwards of 300 lights in the first instance.

Electric Tempering.—The practical results of the application of electricity to tempering of steel are said to have been very satisfactory both in regard to the cost and also uniformity of the product, as well as its application to tempering lower grades of steel into good spring steel. A plant where this tempering process is used on a large scale is able to temper 1,200ft. of steel wire, No. 18 Birmingham wire gauge, per hour, with an expenditure of one horse-power. It is also used to harden or to harden and temper wires, as a different disposition of the current enables one to harden the surface, producing a result comparable to case-hardening; and Bessemer steel, containing one-half of one per cent. of carbon, can be tempered into spring wire, not, however, free from all brittleness.

Electric Traction on the Underground Railway.—At the half-yearly meeting of the shareholders of the Metropolitan Railway Company on Friday last, the Chairman said, in reply to a shareholder, that with regard to electric traction the Board had concluded an arrangement by which a very important experiment would be made at the expense of the inventor. The arrangement with Lord Bury's company did not come to anything. A good many experiments were made, but they found afterwards that they were made on wrong principles. The experiments the company were now going to try would be on the direct-current system, and it was proposed to try it on the omnibus part of the railway. It was a matter that the Board were convinced could be done some day, but, as with the locomotive itself, they would have to go through many painful and fruitless experiments.

The Germain Dry Battery.—A dry cell presenting some novel features has lately been brought out by M. P. Germain, belonging to the French telegraph service. The material employed by M. Germain is cellulose, prepared from cocoanut fibre. This material is cheap, is a good conductor, and possesses great absorptive properties. In the Germain modification of the

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Leclanché cell, the carbon plate surrounded by a mixture of powdered retort carbon and binoxide of manganese rests underneath a cellulose pad soaked with a solution of sal ammoniac; on the top of the cellulose there are two sheets of zinc. Four powerful springs press the cellulose pad tightly against the layer of carbon. Laboratory tests show that this cell does not polarise nearly as rapidly as the Leclanché, and is capable of giving comparatively powerful currents for short periods. The E.M.F. of the cell is 1·5 to 1·6 volts.

The Electrical Industry in Spain.—The efforts of Spanish electricians to advance the industry without the assistance of foreign makers, do not, says the *Manchester Guardian*, appear to have been at all satisfactory. Our contemporary quotes advices from Madrid to the effect that the "Sociedad Española de Electricidad" has been obliged to enter into an arrangement with an English firm in order to continue its operations, and it refers to the probability of the "Sociedad Matritense de Electricidad" being obliged to make similar arrangements with foreign houses. Much regret is expressed at this state of affairs, and the *Economista* of Madrid in referring to the subject remarks:—"It is truly lamentable that a company, such as the Española, which was founded in a spirit of the purest patriotism, with the object of constructing its own machinery, and of using native-made motors, should now have to hand over its business to foreign makers, whose first object will be to prevent the manufacture of electrical machinery in Spain."

Severe Thunderstorms.—Although several violent thunderstorms have occurred during the past few days in various parts of the United Kingdom, and reports still come to hand of the damage done by lightning in the storms of last week, no accidents of a fatal character are recorded. On Tuesday, Wath was visited by a severe thunderstorm, the lightning striking the signalling instruments on the Midland Railway, and the block system had to be suspended. On Sunday a house at Lincoln was struck by lightning and greatly damaged. Last week, at Ipswich, Saffron Walden, Stowmarket, Felixstowe, and Colchester, several buildings were struck, and in many instances suffered considerable damage. At Flint, Huntley Lodge had the roof shattered and the chimneys torn down. At Dumfries, Marchfield House, which is about one and a-half miles from the town, was injured. The lightning struck a vane on the top of a square tower and wrenched a number of large stones from their position, scattering them around the building and breaking several holes in the roof. Another flash entered a detached dwelling at the back, displacing some masonry.

The American "Ball" Electric Lighting Company in Paris.—A correspondent writes as follows:—"In view of the neighbouring successful installations throughout Paris, it seems a pity that the success of Buffalo Bill's Wild West Show at Neuilly should be jeopardised by the uncertainty of its lighting arrangements. For the night of the 11th inst. a grand benefit representation was advertised, including '*Brilliant éclairage electrique par les nouveaux appareils Américains de Ball.*' Many thousands were present at the arena, including Government and local dignitaries; the Indians were engaged in deadly conflict, when suddenly every lamp was extinguished. The performance was stopped and some confusion prevailed amongst the audience, but they were kept seated for about ten minutes, when the light again appeared. Not for long, however, for after flickering and struggling for some time the *nouveaux appareils* again failed, the light expired, and the show broke up. Happily the people preserved good temper throughout, and a brilliant moon, in dispersing them, formed a reliable and efficient substitute for the vacillating arc. If the Ball Company of New York had anything to teach, the transport of a plant across the Atlantic might not seem the straining of a point. But to fail ignominiously at a crucial moment, side by side with that model of arc-lighting, the St. Lazare Railway Terminus, suggests the importation of coals to Newcastle, and very bad coals into the bargain, which it is strange that Buffalo Bill's directors do not recognise."

Curved Electrotypes.—A method, says *Invention*, has been devised in the United States for securing in the process of electrotyping a curved metallic shell of uniform thickness. This is done by the use in the electrotype bath of a curved matrix formed upon a curved elastic plate, and a curved soluble anode suspended at a uniform distance therefrom, the curvature of the anode conforming to that of the matrix, so that when placed in position for the electro-deposition of metal an equal space can be maintained between all parts of the concave surface of the matrix and the convex face of the anode plate. The curved matrix is formed by the use of a curved elastic plate, preferably of thin sheet metal, held in a flat position by a suitable clamping device. While so held, the face of the plate is covered with a layer of moulding wax or other moulding composition. The face of the wax is properly black-leaded, after which an impression of the type form is taken thereon, and the matrix withdrawn from the form, black-leaded, trimmed, built up, &c. When these operations have been performed, and the matrix perfected in every detail, the elastic plate upon which the matrix has been formed is released from it clamping bed and at once returns to its original curvature. The result is a curved matrix, which, after the usual treatment, is ready for the bath. In printing, an electrotype plate is superior to a stereotype, the copper forming its face being harder and more durable than type metal. Its use, however, on cylindrical presses has been regarded as objectionable, because of the difficulty attending the formation of a true curvature of the copper shell. The practice hitherto has been to first secure a copper shell from a flat matrix, and then bend the shell to the required curvature. The bending requires great skill in the handling and manipulation of the shell, the sharp angles and varying faces of the type rendering it liable to crack or bend irregularly, either of which would make it worthless. The method described is said to do away with the necessity, and, consequently, the danger of bending the shell, as it comes from the bath curved as required for the press cylinder, and in condition for immediately undergoing the usual process of tinning, backing, shaving, and trimming.

The Electric Lighting Bills.—On Friday last, on the motion to read the Electric Lighting Provisional Orders (No. 1) Bill a third time, Sir G. Campbell asked whether the Corporation of Birmingham had given their consent to the Provisional Order relating to the city in an express and direct form. Sir M. Hicks-Beach said he entirely repudiated the policy which the hon. member attributed to the Board of Trade of disregarding the wishes of the local authorities in this matter. He might say that only this Session he had overruled a report made by an officer of the Board of Trade in favour of a Provisional Order in a very important case, because the consent of the local authority had been refused. The Corporation of Birmingham were able to take care of themselves. They were represented by as many as nine members in that House, and this Bill had passed through all its stages without a word of objection from any one of them. More than that, communications had passed between the Board of Trade and the Birmingham Corporation which showed ample evidence of the fact that the Corporation were consenting parties to the Bill. He admitted that they had not in so many words recorded their assent; but they had intimated their willingness to do so; and it would no doubt shortly be received at the Board of Trade. The Bill was then read a third time.—On Tuesday last, on the motion of Mr. H. Gardner, in the case of the Metropolitan Electric Supply Bill, Standing Orders were suspended, and the Bill was taken into consideration, and read the third time. On the consideration of the Electric Lighting Provisional Orders (No. 2) Bill, Mr. Bartley moved the following clause:—"Nothing in this Order shall affect the right of any person to supply his own premises and any houses or premises adjacent with energy." Sir M. Hicks-Beach said he had looked into the matter, and there was no doubt whatever that the provisions of the Bill would in no way interfere with or take away the rights of individuals which the hon. member referred to. Mr. Bartley then withdrew the clause. Mr. Baumann moved the amendment he had been precluded from moving earlier, to reduce from three years to two years the period for which consumers were to be bound in unscheduled streets. Sir M. Hicks-Beach accepted the amendment, and said he would see that the consequential amendments were made in another place. The amendment was agreed to, and the Bill was read a third time.

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ON THE DISTRIBUTION OF CONTINUOUS ELECTRIC CURRENTS BY MEANS OF CONDENSERS.—II.*

BY DR. STEPHAN DOUBRAVA.

At the close of my first article I pointed out the fact that by letting the charging and the discharging circuits coincide, the loss of energy in transformation may be greatly reduced. Such an arrangement would not, however, be sufficient, for the simple reason that the energies contained in the charging and discharging waves would distribute themselves according to the resistances. We could, therefore, by the use of condensers with current of more or less high tension, feed incandescent lamps in multiple arc, but nothing would be saved in the conductors. In order to economise in the main leads, the distribution of the energies must be altered by introducing self-induction.

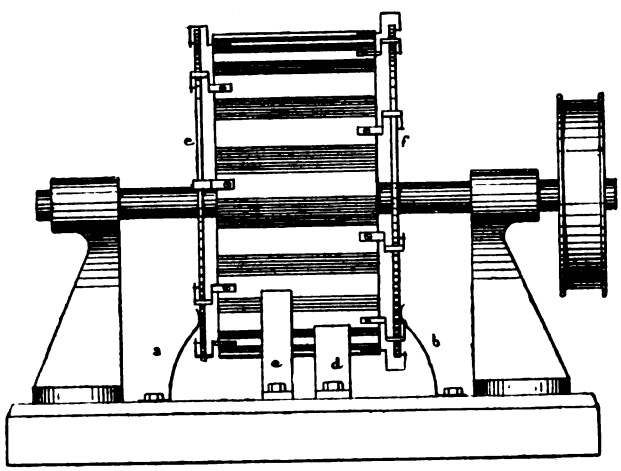

FIG. 1.—The Disjunctor.

In my system the continuous current is led to certain points, where, by means of a disjunctor or commutator, represented in Fig. 1, it is transformed into electric waves, which are used to charge the condensers. This is effected without the slightest sparking, as will presently be made clear. The whole arrangement is diagrammatically shown in Fig. 2, from which it may be seen that the circuits are not metallically closed, but are kept open by the condensers.

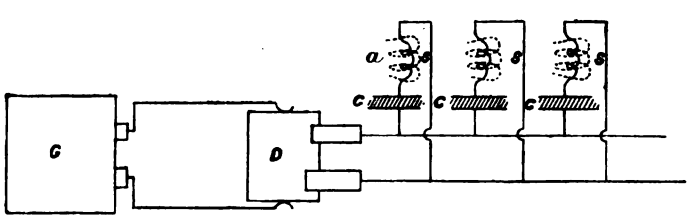

FIG. 2.

G, generator; *D*, disjunctor; *C*, condenser; *a*, primary coils; *s*, secondary coils.

The disjunctor, which was driven in my experiments by a small dynamo of about ½ horse-power, is made of metallic strips, which are separated from each other by strips of non-conducting material. The former are connected alternately to two metallic discs, *e*, *f*. To the latter the main current is conveyed by means of two sliding contacts, *a* and *b*. When the disjunctor is revolving the strips pass under two brushes, *c*, *d*, which are placed in such a manner that they cannot touch one and the same metallic strip simultaneously, and that after leaving two strips they both touch for a certain time the adjacent insulating strips. The brushes are connected with the condensers.

Now, when the disjunctor is turning, the following operations are performed:—Suppose the brushes are touching two metallic strips. Then a current wave is led to the condenser, which will last till the latter has reached the potential difference of the generator. This being the case, the brushes may now safely leave the strips *without any sparking at all*. In this way I have succeeded in breaking circuits of 500 and even more volts without sparking. The brushes having left the metallic strips touch now for a certain time upon the insulation; then again two strips will come in contact with them. But now these strips are in connection with the opposite pole of the generator; therefore a new current wave, but the opposite in direction to the former, will pass to the condenser. This first discharges the latter, and then charges it in the opposite sense till the condenser has again reached the potential difference of the generator. Then again the brushes will move from the strips without sparking, and so on. It may be easily seen that in this way no direct connection between the poles of the generator is possible.

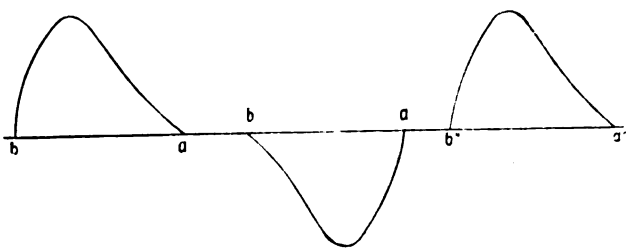

FIG. 3.

The fluctuation of the current in that part of the circuit which lies between the disjunctor and the condenser is represented by diagram Fig. 3. Of course the interruptions must take place only between the points $a\,b'$, a', b'' . . . but never between the points $a\,b$, $a'\,b'$. . . . . Fig. 4 shows the current in that part of the circuit which lies between the generator and the disjunctor, that is in the main conductor.

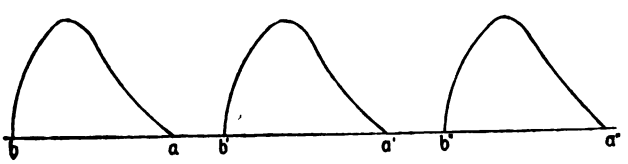

FIG. 4.

It will be easily understood that this current may be made approximately continuous simply by attaching a suitable commutator to the shaft of the disjunctor and connecting the lamps in parallel. In this case each branch contains a condenser, and is in connection with the disjunctor by means of two brushes. Then the charging of the condensers takes place successively, and the current in the mains will appear as represented in Fig. 5.

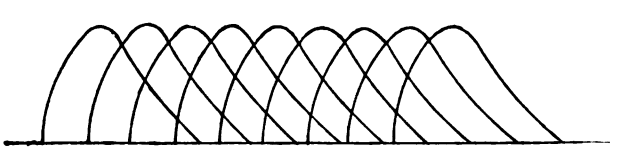

FIG. 5.

With the arrangement described, a number of reversals may be produced far exceeding that of an alternate-current dynamo. For instance, I have used 900—1,500 reversals per second. By this means it is possible not only to attain an efficiency of upwards of 97 per cent., but also reduce the material used for the transformation of the current to the least amount. The condenser required per 16 candle-power lamp need only be 1 square metre area, and the induction coil 0·6 kilogramme (total weight).

I will now establish the theory of the system described.

We may begin time-counting from that moment when the potential difference of the condenser changes from +E to −E, and we denote by

* *See* Article I., *The Electrician*, April 19, p. 676.

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r the total resistance of the charging circuit,
R the total resistance of the secondary circuit,
F the capacity of the condenser,
p its E.M.F. at the time t,
E the E.M.F. of the generator,
l and L respectively, the coefficients of self-induction in the primary and secondary windings of the induction coil,
m the coefficient of their mutual induction,
c and C respectively, the currents in the primary and secondary circuits.

We have then

$$c = -F\frac{dp}{dt} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$cr = p - (-E) - l\frac{dc}{dt} - m\frac{dC}{dt} \quad . \quad . \quad . \quad . \quad (2)$$

$$CR = -L\frac{dC}{dt} - m\frac{dc}{dt} \quad . \quad . \quad . \quad . \quad (3)$$

From (1) and (2) follows by differentiation

$$r\frac{dc}{dt} + l\frac{d^2c}{dt^2} + m\frac{d^2C}{dt^2} + \frac{c}{F} = \theta \quad . \quad . \quad . \quad (4)$$

The partial integrals of (3) and (4) are respectively

$$c = \alpha e^{\alpha t}; \quad C = A e^{\alpha t},$$

where $$A = -\alpha\frac{m\alpha}{R + L\alpha} = \alpha f(\alpha),$$

and $$\left.\begin{aligned}(lL - m^2)\alpha^3 + (lR + Lr)\alpha^2 + \left(\frac{L}{F} + Rr\right)\alpha \\ + \frac{R}{F} = \theta\end{aligned}\right\} \quad . \quad (5)$$

Denoting the roots of the latter by α_1, α_2, α_3 we get

$$\left.\begin{aligned}c &= a_1 e^{\alpha_1 t} + a_2 e^{\alpha_2 t} + a_3 e^{\alpha_3 t} \\ C &= a_1 f(\alpha_1) e^{\alpha_1 t} + a_2 f(\alpha_2) e^{\alpha_2 t} + a_3 f(\alpha_3) e^{\alpha_3 t}\end{aligned}\right\} \quad . \quad (6)$$

By the simultaneous values $t = \theta$; $c = \theta$; $C = \theta$; $p = E$, we obtain

$$\left.\begin{aligned}&a_1 + a_2 + a_3 = \theta \\ &a_1 f(\alpha_1) + a_2 f(\alpha_2) + a_3 f(\alpha_3) = \theta \\ &a_1\alpha_1 + a_2\alpha_2 + a_3\alpha_3 = \frac{2EL}{lL - m^2}\end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (7)$$

from which the values of the constants a_1, a_2, a_3 are obtained. These give

$$c = \frac{2E}{\chi^{(\alpha)}(m^2 - lL)}\left[(R + L\alpha_1)(\alpha_3 - \alpha_2)e^{\alpha_1 t} + (R + L\alpha_2)(\alpha_1 - \alpha_3)e^{\alpha_2 t} + (R + L\alpha_3)(\alpha_2 - \alpha_1)e^{\alpha_3 t}\right]$$

$$C = \frac{2Em}{\chi^{(\alpha)}(m^2 - lL)}\left[\alpha_1(\alpha_2 - \alpha_3)e^{\alpha_1 t} + \alpha_2(\alpha_3 - \alpha_1)e^{\alpha_2 t} + \alpha_3(\alpha_1 - \alpha_2)e^{\alpha_3 t}\right]$$

where $\chi^{(\alpha)} = \alpha_1\alpha_2(\alpha_1 - \alpha_2) + \alpha_2\alpha_3(\alpha_2 - \alpha_3) + \alpha_3\alpha_1(\alpha_3 - \alpha_1)$.

$[\chi^{(\alpha)}]^2$ is a symmetrical function of the roots, and it can therefore be expressed as known by the coefficients of equation (5).

Let T denote the time necessary to charge the condenser completely; the energy given out by the generator during that time is $2E^2F$, and the energy used up in the secondary circuit is

$$\int_0^T C^2 R\,dt;$$

therefore the efficiency $N = \dfrac{\int_0^T C^2 R\,dt}{2E^2F}$.

Now for all $t > T$ we have always $C = \theta$, and we may write

therefore $\int_0^T C^2 R\,dt = \int_0^T C^2 R\,dt + \int_T^\infty C^2 R\,dt = \int_0^\infty C^2 R\,dt =$

$$-R\left(\frac{2Em}{\chi^{(\alpha)}(m^2 - lL)}\right)^2\left\{\frac{a_1^2(\alpha_2 - \alpha_3)^2}{2\alpha_1} + \frac{a_2^2(\alpha_3 - \alpha_1)^2}{2\alpha_2} + \frac{a_3^2(\alpha_1 - \alpha_2)^2}{2\alpha_3} + 2\frac{a_1a_2(\alpha_2 - \alpha_3)(\alpha_3 - \alpha_1)}{\alpha_1 + \alpha_2} + 2\frac{a_2a_3(\alpha_3 - \alpha_1)(\alpha_1 - \alpha_2)}{\alpha_2 + \alpha_3} + 2\frac{a_3a_1(\alpha_1 - \alpha_2)(\alpha_2 - \alpha_3)}{\alpha_3 + \alpha_1}\right\};$$

or, by representing $\chi^{(\alpha)}$ and the expressions in the brackets as functions of the coefficients of equation (5),

$$\int_0^\infty C^2 R\,dt = \frac{2E^2F}{1 + \frac{r}{R}\left(\frac{L}{m}\right)^2 + \frac{rF}{m^2}(lR + Lr)}.$$

Therefore, $$N = \frac{1}{1 + \frac{r}{R}\left(\frac{L}{m}\right)^2 + \frac{rF}{m^2}(lR + Lr)}.$$

By that it is seen that if r—the resistance of the main conductors—is increased, we may always arrive at any desired efficiency by properly choosing the other values, R, L, m, F, l.

THE EFFICIENCY OF A TRANSFORMER.

BY T. SPENCER.

The following method of obtaining the efficiency of a transformer is, I believe, novel, and it would seem to have a considerable advantage over the calorimetric method on account of its simplicity.

Moreover, it is not difficult to see that this method should give accurate results, for it takes into consideration all the different effects such as hysteresis and Foucault currents, periodicity and form of alternation, for all the effect that these things could possibly have is to vary the number of lines of force which pass through the coils at any time. The only assumption which is made is that all the lines which pass through the primary pass through the secondary, which, considering that all transformers are made with a closed magnetic circuit, and also with their primary and secondary very close together, may be considered as strictly true.

Let us write—

c The current in amperes at the time t in the primary.
c' That at the same time in the secondary.
e The E.M.F. at the same time at the terminals of the primary in volts.
r The resistance in ohms of the primary.
r' That of the secondary.
R = The resistance of the secondary circuit which is outside the transformer; it is supposed to have no self-induction in this investigation.
n = The number of lines of magnetic force passing through the coils.
L = A quantity proportional to the number of turns of wire in the primary.
L′ = The same for the secondary.

The last two of the above quantities are supposed to have the proper signs to make the following equations correct. It is not easy to see just what signs they should have, but as in the final result these quantities appear as their squares, a knowledge of their signs is not required.

Now by Ohm's law, and the principle of Maxwell, we have at the instant of time dt the two following relations:

for the primary $$cr = e + L\frac{dn}{dt},$$

and for the secondary

$$c'(R + r') = L'\frac{dn}{dt}.$$

Eliminating $\frac{dn}{dt}$ from these two equations we have

$$cr - e = \frac{L}{L'}c'(R + r'),$$

but $\frac{L}{L'}$ is equal to the constant of the transformer numerically.

Writing m for this we have

$$cr - e = mc'(R + r').$$

Squaring both sides of the equations, and transposing, we have

$$ce = \frac{c^2r}{2} + \frac{e^2}{2r} - \frac{m^2(R + r')}{2r}c^2(R + r').$$

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Multiply all through by dt, and integrate between the limits of zero and unity, we have—

$$\int_0^1 c\,e\,dt = \frac{1}{2}\int_0^1 c^2 r\,dt + \frac{1}{2}\int_0^1 \frac{e^2}{r}dt - \frac{m^2\,(R+r')}{2r}\int_0^1 c^{2'}\,(R+r')\,dt.$$

Now the expression on the left-hand side of the equations represents the total amount of energy which has been absorbed by the transformer in one unit of time.

Now, if we put in the right-hand side of the equations,

$$C_2 r = \int_0^1 c^2 r\,dt,\quad c^{2'}(R+r') = \int_0^1 c^{2'}(R+r')\,dt,\quad \text{and}\quad \frac{E^2}{r} = \int_0^1 \frac{e^2}{r}\,dt,$$

we have—

$$\int_0^1 e\,c\,dt = \frac{C^2 r}{2} + \frac{E^2}{2r} - \frac{m^2\,(R+r')}{2r}\,C^{2'}\,(R+r').$$

Now, it is evident that C, C′, and E are the values of the currents and E.M.F. which we should read from our instruments if they were placed in the two circuits. For what we mean by a volt or ampere in dealing with the alternating system is that pressure or current which when applied to a conductor would heat it, the same as a volt or ampere of direct current would do.

Now, the energy which is being recovered from the transformer as useful energy is that which is being dissipated in the resistance R as heat—that is, $C^{2'}\,R$.

Dividing this by the total energy entering the transformer—that is,

$$\frac{C^2 r}{2} + \frac{E^2}{2r} - \frac{m^2\,(R+r')}{2r}\,C^{2'}\,(R+r'),$$

we have, after reducing, the efficiency equal to

$$\frac{2r\,R\,C^{2'}}{C^2 r^2 + E^2 - m^2\,(R+r')\,C^{2'}}.$$

THE MANDROUX PORTABLE TESTING APPARATUS.*

M. Mandroux, well known for his improvements in telegraphy and telephony, has recently devised a very compact set of portable testing apparatus, comprising a galvanometer, a dial pattern resistance-box, a condenser, battery, and several varieties of keys. One of the objects which M. Mandroux had in view was to make the connections as simple as possible, and enable the operator to change from one test to another by merely altering a plug. In addition to achieving this result in a very successful manner, M. Mandroux has introduced several interesting improvements into the various parts of the apparatus.

The galvanometer (Fig. 1) has a double needle consisting of two strips of steel joined together as shown, in the shape of an X. These two needles being oppositely magnetised the system is rendered astatic, and thanks to their peculiar X shape the deflections of the instrument are practically proportional up to 25deg. Owing to the great breadth of the needles the damping effect of the air renders the galvanometer very dead-beat. The suspensory arrangement permits the use of large, strongly-magnetised needles, rendering the sensitiveness of the instrument very great. As the galvanometer is intended to undergo considerable rough usage, M. Mandroux includes in each set of apparatus a box of 15 ready-prepared cocoon fibres. These fibres are cut to the required length and are provided at either end with a small aluminium ring. When replacing a broken fibre the only thing to be done is to pass one ring over the hook at the top of the instrument, and the fibre which is kept stretched by the weight of the lower ring can then be easily passed down the tube and attached to the hook belonging to the needles.

The resistance-box (Fig. 2) is of the dial pattern, in which the dial plugs are replaced by a peculiar form of switch. The contact pieces and the centre piece are turned so as to make the space between them a V-shaped groove. A sliding wedge-shaped contact moved by a small handle, the axis of which coincides with the centre of the central block, fits into this groove, and to ensure good contact it is pressed well into its place by a powerful spring. Resistances can, therefore, be cut in or out without breaking the circuit, as is the case whenever a plug is moved in the older form of dial pattern resistance-box. Each of the four dials has its own switch, and the four switches are all mechanically connected by means of a Maltese cross arrangement, analogous to that employed in some electricity counters, each complete circle performed by the switch of one dial causing that of the next dial on the left to move one unit. Thus, ten revolutions of the switch of the unit dial makes the switch of the ten dial move once round the circle. This movement takes place backwards or forwards, according as the unit switch is moved in one direction or the other. As it would be a great drawback to be obliged to move the thousand and the hundred dial by means of the unit switch, M. Mandroux has a device by means of which any one of the dial switches can be rendered independent of the ones on the right of it. It is only necessary to press on the handle of the switch in order to lift a pin, which penetrates into one of the ten holes of a small disc, which is in mechanical connection with the Maltese cross. When the handle

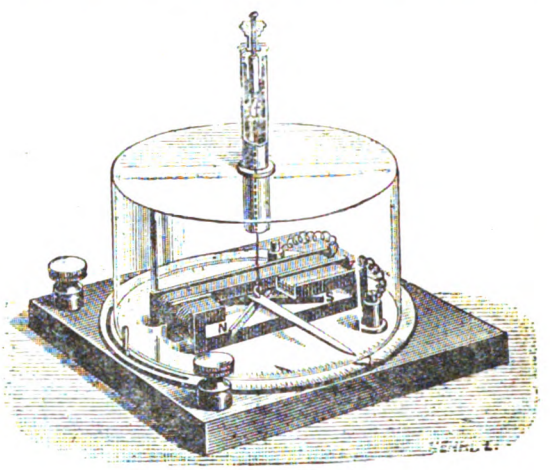

Fig. 1.—The Mandroux Astatic Galvanometer.

is no longer pressed the switch is immediately thrown into gear again. The introduction and suppression of resistance is therefore continuous, and the needle does not undergo any sudden and violent jerks due to the breaking of the circuit.

The condenser presents peculiarities only in the mode of construction. Each sheet of mica, after having been carefully wiped and dried, is gently heated and covered with five or six layers of shellac varnish. The sheets are then dried in a stove for some three hours, the heat being moderate and constant. When the mica is dry enough the condenser is built up in the usual manner, care

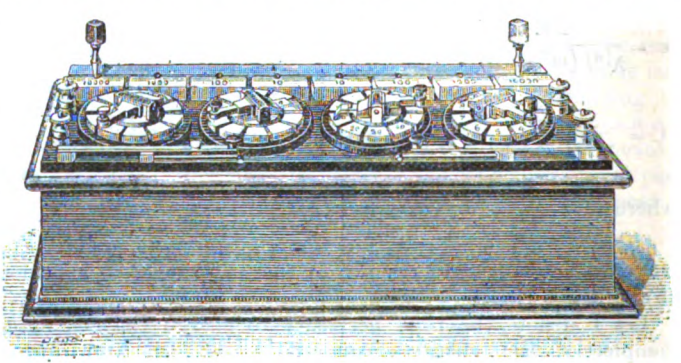

Fig. 2.—The Mandroux Dial Pattern Resistance Box.

being taken to perform this operation on a clean sheet of iron, which is kept slightly hot. When the required number of layers of mica and tinfoil has been reached, the whole, while still hot, is placed in a press and is cooled under strong pressure. The following instance will give an idea of the results obtained by this process. A condenser with 100 non-varnished mica sheets, built up in the ordinary manner, had a capacity of ·35 microfarads and an insulation resistance of 800 to 1,000 megohms. When this condenser was pulled to pieces and reconstructed as indicated above, its capacity had only diminished by ·02 microfarads while its insulation resistance had increased to 15,000 megohms.

The reversing key devised by M. Mandroux is also distinguished from that in ordinary use by an important improvement. Instead of the ebonite clamp usually employed to keep the key down, M. Mandroux provides the keys with two small projections. When one key is depressed, it presses against a small knob at the end of flexible strip of metal, the projection is caught in a small notch in

* Extracted from *La Lumière Électrique*.

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the knob, and the key is kept down. On depressing the second key, it is caught in the same way, but not before it has released the first.

By means of the Mandroux apparatus all the tests required in ordinary telegraph work can be taken on the spot, and the various improvements introduced will probably cause it to be used in laboratories and elsewhere.

THE PROPOSED GOVERNMENT STANDARDISING LABORATORY.

The following circular has been issued by the London Chamber of Commerce, at the instance of the Board of Trade, with a view of ascertaining the probable amount of support that a Government Standardising Laboratory would meet with from the electrical industry :—

"Dear Sir : The Board of Trade desires to avail itself of the organisation of the London Chamber of Commerce for the purpose of ascertaining the probable extent to which a Government Laboratory for standardising electrical instruments would be used :—

(*a*) By supply companies for the certification of meters, voltmeters, and ammeters, and

(*b*) By manufacturers of electrical instruments.

Your replies to the accompanying questions are therefore requested. The individual replies will be considered as confidential, and only the aggregates will be published.—Yours, faithfully,

Kenric B. Murray, Secretary.

1. Supposing a standardising laboratory to be ready at the commencement of the year 1890, how many ordinary house meters do you expect to send in for certification ?
2. How many ammeters do you expect to send in ?
3. How many voltmeters do you expect to send in ?
4. State whether you send in as an undertaker or as a manufacturer ?"

The following addendum has been sent to certain manufacturers and agents, with the view of avoiding duplicate returns relating to the same instruments :—

"Please take precautions in sending your replies to the circular against possible repetitions of the same instruments by manufacturer and agent, or supplier, *e.g.*, yourself and....."

STANDARD TYPES OF APPARATUS.

The following circular has been issued by the Committee of the Electrical Section of the London Chamber of Commerce to all members of the Section :—

"Sir : The Sub-Committee appointed by the General Committee of the Electrical Section of this Chamber to consider the recommendation of standard or uniform types desire to obtain information as to the extent to which the British Association Screw Thread has been adopted by the electrical trade up to the present. No steps have been taken by the British Association to bring their standard screw gauge before the trade other than the publication in their 1884 (Montreal) Report of the report of their Committee. This Committee consisted of Sir Joseph Whitworth, Sir William Thomson, Sir F. J. Bramwell, Mr. A. Stroh, Mr. Beck, Mr. W. H. Preece, Mr. R. E. Crompton, Mr. E. Rigg, Mr. A. Le Neve Foster, Mr. L. Clark, Mr. E. T. Wood, and Mr. Buckney, and were 'appointed for the purpose of determining a gauge for the manufacture of the various small screws used in telegraphic and electrical apparatus, in blockwork, and for other analogous purposes.' In the Report of the British Association for 1885 (Aberdeen) it is stated that the standard screws 'have been officially adopted by the telegraph department of the Post Office, and this step alone may be relied upon to ensure their general adoption by the telegraphic and electric instrument trades in the course of a few years.' In the 1887 (Manchester) Report the following statement was made by Mr. Preece :—'Owing to the large number of telegraph instruments made by different manufacturers, the number of screws of different forms and sizes in use was very great, and this was found to be a great disadvantage and a great source of expense. When the Post Office commenced to manufacture its own apparatus it was decided to make all parts to template, so as to be interchangeable, and it was also decided to adopt some standard for screws. The standard recommended by the Committee appointed by the British Association is now being introduced in all instruments and apparatus manufactured by and for the Post Office Department, a circular to that effect having been issued to all firms manufacturing for the General Post Office.' Notwithstanding the above a considerable number of manufacturers of electrical instruments are still quite unacquainted with these screws, and the Committee feeling that the practical value of such a standard depends largely, if not entirely, on the extent to which it is adopted, invite communications from the trade upon the subject, and for that purpose have drawn up a set of questions, sent herewith, to which your answers are requested. It should be noted that the enclosed questions need not entail any disclosures whatever as to the actual extent of your business ; only the proportion or percentage is asked for, but actual figures may be given. The result of the analysis of the answers to these questions will be communicated to the members of the London Chamber of Commerce, in order that those who do not use the screws may see whether their use is sufficiently general to induce them to adopt them.—Yours faithfully,

Kenric B. Murray, Secretary.

Electrical Trades' Section.

1. Do you use the British Association standard screw gauge in your manufacturing business ?
2. If so, what is the proportion of small screws of this gauge compared with other screws smaller than the Whitworth sizes used by you ?
3. Also, if so, do you find that for ordinary purposes you require to use other screws than those of the Whitworth and the British Association gauges ?
4. If you do not use the British Association screw, have you any reason other than that you do not care to incur the expense and trouble involved by their adoption ?"

PARLIAMENTARY INTELLIGENCE.

The Select Committee on the Metropolitan Electric Lighting Schemes.

Friday, July 19

The Select Committee of the House of Commons resumed consideration of the Bills on Friday under the presidency of Sir G. Trevelyan.

Mr. A. GRAY, on behalf of the Board of Trade, said the Board of Trade had power to provide for reciprocity between the local authority and the electric companies as to breaking up the streets, and they could also provide for it in the case of owners and operators in the case of the alteration of pipes, but the power to the gas company to dig trenches for electricity companies could only be given by the Committee considering the Provisional Order Bills.

On the suggestion of Mr. PEMBER, counsel retired for an hour to consult with a view to agreeing upon a clause ; on returning,

Mr. PEMBER said they had agreed to a clause providing for the reciprocity between the gas and the electric companies in digging trenches. The preamble would state that the Provisional Order had been confirmed as amended.

Mr. POPE concurred, and Mr. GRAY said of course the Committee had power to make the alteration if it thought fit.

Mr. SAUNDERS also agreed.

The CHAIRMAN said if Parliament thought it an undue provision they could strike it out.

The new clause was then read, providing for fourteen days' notice of new works and for the exercise of the reciprocity mentioned.

Mr. FREEMAN then objected that the proviso which had been inserted for the protection of the London County Council was too limited, and he proposed other words to be inserted in its place.

Some discussion took place on the point, but on an objection by Mr. FLOYD,

The CHAIRMAN said that as Mr. Freeman could not show that any power of the County Council was not gained by the original proviso, the Committee upheld that proviso.

Mr. GRAY suggested that the rights of the water companies should be protected in the same way.

Mr. SAUNDERS said that the water companies were satisfied with the clauses in the Bill, and

The CHAIRMAN said it was unnecessary.

A verbal alteration was made in the clause, which was then approved by the Committee.

The London Electric Corporation Bill was gone through and approved after alterations had been made providing that they should not acquire the undertaking of or associate themselves with any other electric company unless authorised by Parliament to do so ; that the accounts should be examined by a Board of Trade auditor ; and that they should not break up any bridge, or the approaches thereto, without the consent of the authority in whom they were vested, and in accordance with plans approved by the authority or settled by arbitration.

The other Bills having been gone through, and similar amendments inserted, the Committee closed.

At a subsequent meeting of the Committee the clauses were formally adopted, and report was made to the House.

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The Electrician.

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THE "SUNK" LIGHTSHIP CABLE.

The second and final Report of the Committee appointed by the Board of Trade to inquire into the desirability of Electrical Communication between Light-Vessels or outlying Lighthouses and the shore has just been published. It is, we regret to say, adverse to the proposal; but much as we desire to see a complete system of electrical communication established round the coast we cannot pretend to be surprised at the result of this particular inquiry, or very much discouraged by it. The references to which the Board of Trade restricted the Committee were extremely limited, and not of the kind which the public have been constantly demanding since the inquiry was started. The experimental telephonic cable connecting the "Sunk" lightship with the shore at Walton-on-the-Naze was the sole matter on which the Committee had to report; and the only question arising out of it was whether the cost of laying and maintaining this cable, amounting, as it appears, to nearly £5,000 was justified by the service it had rendered during the four years of its existence. Exactly two years ago the Committee finished a preliminary inquiry, recommending that before a final opinion ought to be formed on this point a further trial of eighteen months would be desirable; and now after this

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interval has elapsed the opinion foreshadowed in the earlier Report has been confirmed, the Committee recommending that the service shall be discontinued. As the Trinity House authorities announce that failing the sanction of any further expenditure in respect to the experiment it will not be possible with the means left available to renew any portion of the cable should it become broken, it follows that unless private enterprise or public philanthropy now comes to the rescue the cable will soon have to be abandoned.

It will be remembered that the chief object of this inquiry was to ascertain whether electrical communication of the kind referred to would facilitate the saving of life at sea, the saving of property being a quite subordinate matter, and the further question of utilising it as a means of signalling for shipping and commercial purposes being decided in the negative on the first inquiry. There only remained, therefore, the simple question what number of lives the "Sunk" cable had been the means of saving. It happens that the past two or three years have been exceptionally free from serious storms and fogs; and it is also a fact that an additional number of lightships have latterly been established in the district, the result being that wrecks were less numerous than during former quinquennial periods, and consequently there was less need for life-saving appliances of any kind. The inevitable conclusion of the Committee under these circumstances is that "the expenditure involved is not commensurate with the advantages gained." Sir EDWARD BIRKBECK, chairman of the Royal National Lifeboat Institution, who was a member of the Committee, dissents from the Report, however, on this issue, pointing out that the information given of the exact position of the stranded vessels by means of the "Sunk" lightship telephone service has been of great value to the crews of the Walton and Harwich lifeboats, enabling them to take the most direct course to the scene of disaster, instead of having had to go in the first instance to the light-ship to obtain the necessary directions; and he recommends a further trial of at least five years, the expense to be met by an annual Parliamentary vote.

We sincerely hope that steps may be taken to induce Parliament to accede to this proposition, or to obtain the funds by national subscription until the experiment has had a fuller trial, or has been repeated elsewhere under different conditions. It appears that the "Sunk" is not the point which the best authorities would have chosen for the locality, the Trinity House expressing a decided preference for the Gunfleet Lighthouse, on account both of situation and cost. Holding this view, we could hardly expect Trinity House to favour the cable at the "Sunk;" nor can we be surprised at the members of that influential body declaring that if they have to provide the money they would much prefer to spend it on additional lights and fog signals—in other words, on appliances for preventing wrecks rather than on "what seems to them at best but the means for the occasional relief of a casualty." On the other hand, they report very favourably indeed of the cable itself, furnishing the information on which the Committee's Report on this part of the subject is founded. The words of the Report are well worth quoting, and will be borne in mind by those who are warmly advocating the extension of electrical communication for purposes of national defence and the protection of our commerce: "We are of opinion that the experiments which have been carried on since December, 1884, in connection with the 'Sunk' lightship with the mainland, have completely shown the possibility of establishing electrical communication, even in positions where, as is the case at the 'Sunk,' the condition of tides and currents, as well as the foul and rocky bottom, are most unfavourable."

This is the highest compliment that could be paid to the firm which had charge of the undertaking; for the difficulties were not so much those specifically referred to, as the more serious ones of maintaining attachment to the ship as she shifted with the sands, and of preventing fouling with her moorings as she turned with the tides. Interruptions have been rare, and always promptly repaired, generally by the men on the spot. A considerable amount of chafing to the outer armour in the vicinity of the vessel is unavoidable, and will probably always require supervision at intervals. But the experience of the past four years has pretty well defined the problem to be solved, and cable manufacturers now know exactly what provisions have to be made for keeping such connections intact. This point being settled by the experiment at the "Sunk" we have little fear that the Report upon which we have commented will seriously delay the wider schemes of electrical coast communication which the country so much desires. In this relation it is interesting to note a communication made to the Committee by the Inspector of Danish Lights, about which so much has been written. It appears that the telegraphs connected with the Danish light stations belongs to the Government system, and forms no part of the lighthouse service, although the keepers are permitted to accept and send telegrams at the usual charges. None of the Danish lightships are connected by cable, but, on the other hand, most of the "isolated island lighthouses" are connected with the mainland telegraphs, as are also most of the lifeboat and rocket stations. We need not dwell on the extreme usefulness of a service such as that, and we confidently hope that the time is not far distant when the British Isles may boast of one not inferior to it.

REVIEWS.

Electricity: Theoretically and Practically considered by the aid of Thermo-Electricity. By ARTHUR RUST. (London: E. and F. Spon, 1889.)

The writer of this pamphlet has built a thermopile containing some 6,000 elements, of which he gives the following description:—

"The heater which occupies the interior of the cylindrical arrangement of elements is a slow combustion stove of particular construction. In the centre it is fed by a continuous tube charged with coke from the top; this opens at the end into a fire-box or basket closed at the bottom by bars, and on these bars are placed a cone which causes an outward distribution of the fuel as it descends from the supply-chamber. Around this supply-chamber there is a concentric casing filled with sand, which retains the heat for many hours after the fire has burnt out, and prevents the heating and cooling from taking place too rapidly. Outside this last casing there is again another casing concentric with it, and between these are three spiral flues. The heat and products from the fire ascend by these flues, and at the top of the casing there are three apertures, by which the products of combustion are delivered in a common up-take which leads to the chimney.

In this way, and by the help of regulating flues, the exterior casing is very equally heated; a sufficient temperature is easily maintained, and this without any risk of overheating the elements. The inner faces of the thermo-elements are in close proximity to this heated casing, although not electrically connected with it. Thus the requisite heat is supplied to the couples, and each row being connected together by binding screws, for convenience, the total number of elements can be arranged row by row, either in one circuit or multiple arc as desired. The electrical current flows as described, and can be employed for any purpose for which it is required.

The stove, simply as a stove, was found capable of producing a tremendous heat, and from an actual trial in testing, before the thermo-elements were added, allowing all the dampers, etc., to be out, and giving it full play, within twenty minutes of lighting the fire such heat was generated that lower parts of the iron furnace melted like wax.

This electrical furnace, this magnopile, gave in actual work an E.M.F. of 96 volts, with a resistance of 11·5 ohms. This resistance

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need not have been more than 10 ohms, and better results can yet be obtained. The cost was at the rate of about 6d. per 10 hours."

We regret to have to add that beyond the above quotation we have failed to find any hint or suggestion of the slightest value in this book. The author has taken no pains to qualify himself for the task of propounding a new Physical Theory of Electricity; his ideas so far as they are new are certainly untrue, and so far as they may possibly be true, they are by no means new. In fact, the pamphlet furnishes one more instance of a novice rushing in where Sir William Thomson scarcely dares to tread.

THE BIRMINGHAM ELECTRICAL EXHIBITION.

The arrangements for the opening, on August 1st, of the Exhibition of Electrical and Industrial Appliances in Bingley Hall, Birmingham, are rapidly approaching completion. About twenty-six thousand feet of space are at the disposal of the Committee, most of which, practically, will be devoted to electrical appliances. Our readers will remember that the exhibits are grouped in three sections; one will consist of a complete display of electric lighting upon all known systems and combinations, and of all systems of electric transmission of power; the second will embrace dynamos, arc and incandescent lamps, switches, electroliers, and motors; and the third, telegraph and telephonic apparatus, phonographs, electric bells, and all kinds of electric machinery and appliances. All the machinery in motion will be worked by electricity, five powerful engines to work the dynamos being supplied by Messrs. Robey and Son, Ruston and Proctor, and Greenwood and Batley, and the boilers by Messrs. Galloway and Sons.

The lighting of the hall has been entrusted to the leading electric-lighting firms, among them the Anglo-American Brush Company, Elwell Parker, Ernest Scott and Co (Newcastle-on-Tyne), the Planet Electric Light Company, Messrs. Goldston (Middlesbrough), and Shippey Brothers. The motors for driving machinery for the working exhibits will be supplied by Elwell Parker, Messrs. Immisch and Co., Crompton and Co., and Messrs. Laurence, Paris, and Scott.

One of the features of the Exhibition is to be a miniature coal mine, in full operation. Excavations are being made in the basement of the hall, in which a seam of coal will be represented. Lord Shrewsbury has lent all the machinery necessary to coal-getting. A tramway will convey the coal, which will be worked by a staff of miners, to the pit's mouth. The mine will be lighted by electricity, but visitors will be asked to carry a safety-lamp into the workings, and this will greatly add to the air of realism which it is intended to convey. Another novelty will be a telpherage railway, worked by electricity. A wire will be run round the hall, and engine and coaches to carry passengers will be suspended.

The electrical exhibits will be of the utmost value. Birmingham is at the present undecided as to whether it will adopt electricity as an illuminant, and the exhibits have been carefully arranged to show the different systems at their best. Amongst the exhibitors are the Edison and Swan United Electrical Company, who are showing a number of lamps of a very elaborate kind; Messrs. Crompton and Co., who are showing their new improved electrical cranes; the Electric Power Storage Company, who exhibit storage cells; and Woodhouse and Rawson (Limited), who show an assortment of switches and fittings. There are in all about 300 exhibitors, being considerably more than at the Exhibition of 1886.

Permission has been obtained from the property owners in the neighbourhood to run a wire along the roofs of the houses, and at intervals along the route large arc lamps are to be suspended from an arm placed over the shop fronts. Electricity will, moreover, be the illuminant in King Alfred's-place, the town end of Broad-street and Paradise-street, and if permission can be obtained the lighting will be continued to the Town Hall, a considerable distance. Altogether it is hoped that when Lady Randolph Churchill opens the Exhibition on Friday next a very interesting display will have been got together.

ON FREE IONS.*

BY W. OSTWALD AND W. NERNST.

The hypothesis originally propounded by Clausius, that in an electrolitically-conducting liquid a portion of the electrolytic molecules are split up into ions, has, as is well known, recently received a further development at the hands of H. Arrhenius, who has shown how to determine the proportion of the whole quantity of the electrolyte, which under given conditions is split up into ions. A considerable number of quite different methods of investigation have led to results which all agree in indicating that in the case of most neutral salts, as well as of the stronger acids and bases, instead of a small portion only of the electrolyte being split up, as had hitherto been assumed, almost the whole is split up in this way into ions, leaving only a small proportion of molecules existing in a combined state in the solution. The older and comparatively indefinite theory gave a complete and what appeared to be a satisfactory explanation of the phenomena, but the new and definite form appears to involve some contradictions. One of the present authors has shown ("Zeitschrift für physikalische Chemie," Vol. II., p. 271, 1888) that the existence of free ions in an electrostatically-charged electrolyte must be assumed, as the contrary assumption would be in contradiction with the fundamental laws of electricity.

The authors observe, however, that so many attacks have been made upon their method of experiment and from such weighty sources, the experiments in the form described being asserted to be impossible, that they have endeavoured to place their conclusions upon an unassailable experimental basis. It is well known that the electrical charges in motion in case of electrolysis are beyond comparison greater than those which can be obtained electrostatically, and therefore specially delicate apparatus has to be employed in order to observe the electrolytic action of statical electricity. As an exemplification of this the authors point out that, according to their results, in order to obtain a sufficient quantity of electricity from a single discharge of an air condenser to liberate a milligramme of hydrogen the linear dimensions of the condenser would have to be something like a kilometre. However, as they point out, a milligramme of hydrogen would occupy 12 or 13 cubic centimetres, and as a bubble 0·1 millimetre in diameter can be perceived by means of a simple lens, and one 0·01 millimetre in diameter by means of a microscope, the linear dimensions of a condenser necessary to give an observable effect would be measured in decimetres or centimetres. The authors state that the best means known to them for the observation of small quantities of hydrogen, lay in the use of Lippmann's capillary electrometer. The apparatus actually employed in the experiments consisted of a glass tube 30 to 40 centimetres in length, provided with a stop-cock, and terminating in one end in a capillary tube of such dimensions that when filled with mercury the pressure just exceeded that of capillarity, so that mercury began to flow out in drops. The tube was fixed vertically in a holder, and its end was allowed to dip into dilute sulphuric acid. The mercury was then drawn up into the capillary tube by sucking at its upper end, and the acid allowed to take its place. The bounding surface between acid and mercury was then brought, by means of the stop-cock, to a fixed position at about the middle of the capillary tube. A platinium wire melted into the tube gave the means of making electrical connection with the mercury. With this apparatus the following series of experiments was made:—

(1). The large glass globe had its globular surface covered with tin foil and its neck varnished with a solution of shellac in order to make the insulation as good as possible. It was then filled with dilute sulphuric acid, and the contents of the sphere were put into electrical communication with the acid, in the Lippmann electrometer tube previously described, by means of a wet fibre. The sphere was insulated by being placed on a sheet of gutta percha. The positive terminal of a small electrical machine was then connected with the outer coating of the sphere, while the mercury of the capillary electrometer was earth connected. As soon as the electrical machine was set in motion the meniscus of the capillary electrometer moved upwards, and at the same moment gas bubbles were separated and divided the mercury thread at several parts. In this way a positive charge was communicated to the external coating of the sphere and this would attract and bind the negative charge upon the inside, repelling the positive charge; the repelled charge would pass through the wet fibre to the capillary electrometer, and then through the platinum wire in connection with the latter to the earth. The authors observe that a closed circuit is not necessary, the resultant motion of electricity being entirely due to induction. Now, it was shown in the Paper previously quoted that the existence of free ions in an electrically-charged electrolyte followed from Faraday's law, according to which the motion of electricity in electro-

* "Zeitschrift für physikalische Chemie." Vol. III. Abstracted from separate impression communicated by the authors.

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lytes only takes place simultaneously with that of the ions. If, then, the motion of electricity due to the inductive action took place by metallic conduction, as some physicists of high standing have asserted might possibly be the case, there would be no reason for the production of hydrogen at the electrode, and the fact that this occurs, shows that the conduction is electrolytic, and therefore that a separation and motion of the ions has taken place. It follows, therefore, that the outer coating of the sphere acquires a positive charge; the negative ions (SO_4) of the sulphuric acid are attracted, while the positive ions (H) are repelled, and travel through the wet fibre to the mercury, where they give up their charges, and appear as ordinary hydrogen, which agrees with the results obtained in the Paper previously referred to. The objection might be made, that the liberation of the hydrogen might possibly be due to electrolytic action taking place through the glass instead of being caused by inductive action. This objection, however, is answered by the fact that the Leyden jar employed kept its charge exceedingly well. Moreover, the authors' conclusion is confirmed by the following experiments:—

(2). While the outer coating of the sphere was in connection with the earth, a charge of positive electricity was communicated to the acid within it by means of a wet fibre. The connection with the electrical machine was then broken and the acid was connected again by a wet fibre with the acid of the capillary electrometer, the mercury being put in connection with the earth. The same phenomenon as before was then observed, namely, the thread of mercury rose in the tube, and bubbles of gas were observed between it and the acid. The explanation of this result is similar to that of the former one; while the acid was being charged positively from the electrical machine, the negative ions lying at the point of contact with the wet thread were neutralised and united with the metal. The positive ions would distribute themselves according to the laws of electrostatics over the surface of the conductor; when the acid was then earth-connected through the capillary electrometer, there was a flow of positive electricity with the hydrogen to the mercury, and the electric charge escaped. The hydrogen remaining in the form of bubbles, and without electrical charge.

(3.) The acid of the capillary electrometer was connected with the earth, and the mercury with a metal plate having sides a few centimetres in length. This plate was then brought near to a second plate charged negatively, whereupon bubbles of hydrogen immediately appeared in the neighbourhood of the meniscus. In this case positive electricity flowed through the earth towards the first plate, and the bubbles of hydrogen observed evidently consisted of the gas accompanying the positive current.

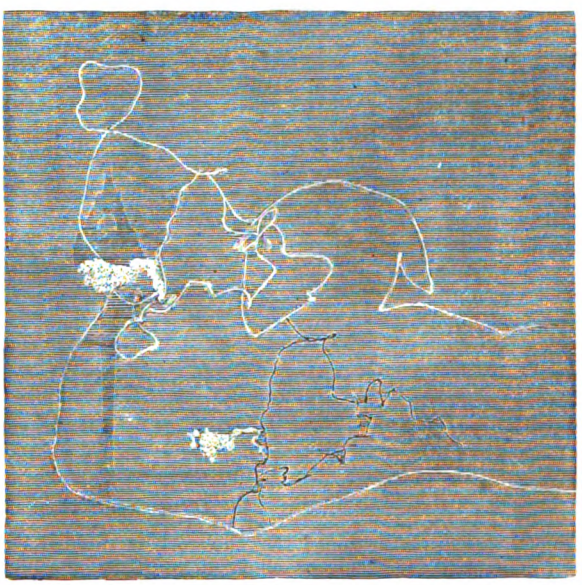
(4.) The upper mercury surface of an ordinary Lippmann capillary electrometer was connected with an insulated metallic sphere, and the latter was then acted upon inductively by the approach and subsequent removal of a rubbed rod of glass or ebonite, and the thread of mercury in the electrometer was seen to move through a perceptible distance in the direction indicated by the previous results. The motion in the capillary electrometer is due, as is known, to the changes in surface tension, and arises from alterations in the difference of potential of the electrical double layer at the bounding surface between the mercury and acid, that is to say, the mercury meniscus becomes polarised through the inductive action. Now polarisation can only arise from material changes in the boundary layer. The motion of electricity in the acid must therefore be of an electrolytic character, that is to say, it must be accompanied by the motion of the ions, so that even in the case of the motion of this extremely small quantity of electricity there is no perceptible sign of metallic conduction.

In order to show that under the given conditions a definite electrolytic action was to be expected, the author then repeated the experiment quantitatively. The capacity of the globe for a charge of short duration was determined by alternately charging and discharging it through a sensitive galvanometer many times in a second, and the throw of the galvanometer was compared with that due to the action of a small fraction of the charging E.M.F. applied directly to the galvanometer circuit. It was found in this way, that the capacity in electro-magnetic measure was $6{\cdot}9 \times 10^{18}$ C.-G.-S. units. In making the experiment the globe was charged to a potential difference of 800 volts which would give it a charge of 8×10^{10} C.-G.-S. units, so that the quantity of electricity due to induction which passed through the capillary electrode was $5{\cdot}5 \times 10^{-7}$. Now a C.-G.-S. unit of electricity liberates 0·014 milligrammes of hydrogen, so that, under the ordinary conditions of temperature and pressure, $0{\cdot}3 \times 10^{-7}$ cubic centimetres of hydrogen would be expected to appear in the capillary tube. As a matter of fact a bubble of hydrogen was obtained of a length about double that of the internal diameter of the capillary tube. Now it was observed that in order ot force the mercury down to the position of the bubble in the capillary tube, the glass tube attached to the latter had to be filled with mercury to the height of 23 centimetres, the capillary tube having been previously filled with air. From this observation, with the aid of Quincke's tables for the surface tension of mercury, the internal radius of the tube at this point was calculated and found to be $3{\cdot}7 \times 10^{-3}$ centimetres. With these data, and assuming the form of the bubble to be a spheroid with principal axes r and $2r$, the volume was found to be $4{\cdot}3 \times 10^{-7}$ cubic centimetres, which, considering the nature of the experiment, may be regarded as in very good agreement with the predicted value. The authors consider themselves justified in concluding from these experimental results that the motion of electricity in electrolytes in obedience to Faraday's law, is due entirely to the motion of material particles, namely, ions, and that in an electrostatically charged electrolyte there must exist a certain proportion of free ions corresponding to the amount of charge. These ions will, as before pointed out, distribute themselves in obedience to the laws of electrostatics over the surface of the conductor. The authors observe that it might possibly be suggested that the ions are set free at the moment of charging, so that a kind of electrolysis takes place within the liquid simultaneously with the flow of electricity. Clausius, however (Poggendorff's *Annalen*, Vol. CI., p. 338, 1857), has pointed out that this is in contradiction with the experimentally observed fact that electrolysis can be produced by the very weakest E.M.F., which would be impossible according to this hypothesis, for then electrolysis could not begin until the electricity had done a definite amount of work.

(To be continued.)

AN EXTRAORDINARY LIGHTNING FLASH.

The accompanying block is taken from a photograph sent us by Mr. A. H. Baird, of Edinburgh, and which was taken about



9 p.m. during the storm of the 6th June last. The flash at the time did not appear to be of the usual zigzag character, but left the impression of a confused whirl, just as is shown in the photograph. At the moment the flash occurred Mr. Baird was outside a window, holding the camera in his hands.

BOOKS, &c., RECEIVED.

"Applications Industrielles des résidus provenant des Piles aux Bichromates." By GEORGES FOURNIER. (Paris: Bernard Tignol.)

"*Proceedings* of the Royal Society of Edinburgh." Vol. XVI.

"Electricity: Theoretically and Practically considered by the aid of Thermo-Electricity." By ARTHUR RUST. (London: E. and F. N. Spon.)

"Illustrated Catalogue and Price List of Mayfield and Co."

"Die Electrische Beleuchtung im Verhältuiss sur Hadtverwaltung." By Dr. W. SCHRADER. (Magdeburg: Albert Rathke.)

"L'Électricité Appliquée à l'Art Militaire." By Colonel GUN. (Paris: J. B. Baillière et Fils.)

"Traité Théorique et Pratique d'Électrochimie." Vol. IV. By DONATO TOMMASI. (Paris: E. Bernard et Cie.)

Price List of Incandescent Lamps and Holders. The Edison and Swan United Electric Light Company (Limited).

"Modern Views of Electricity" (*Nature* Series). By OLIVER J. LODGE, D.Sc., F.R.S. (London: Macmillan and Co.)

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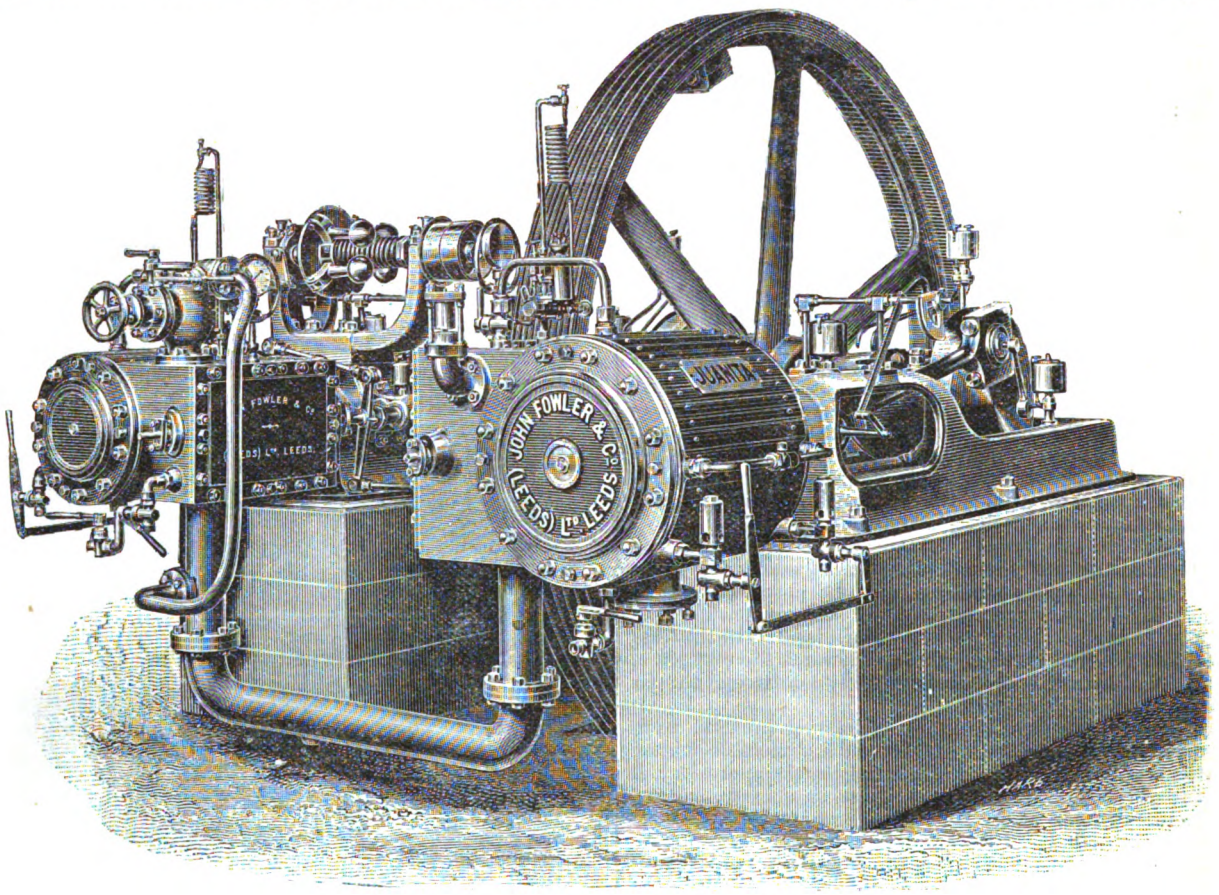
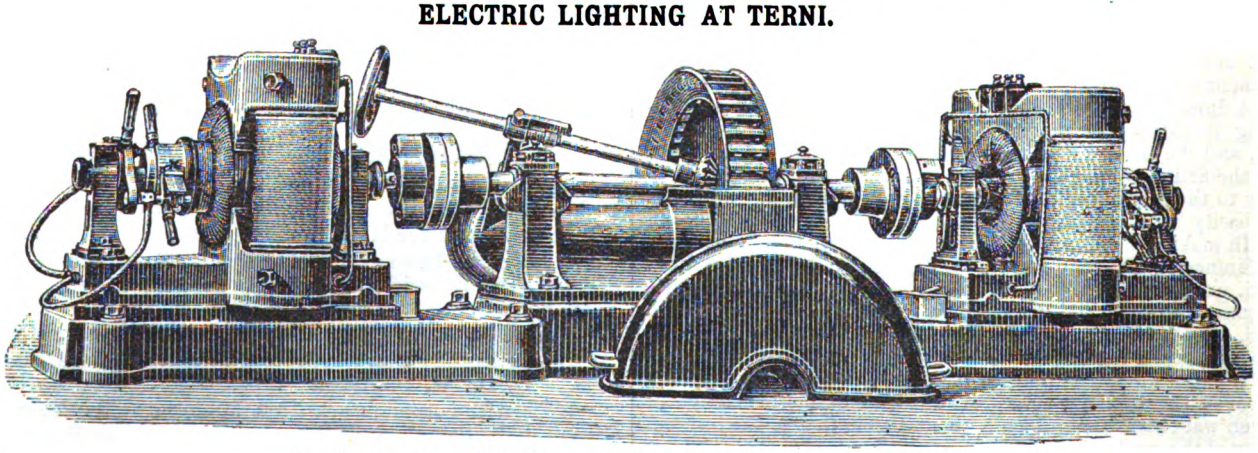
COMPOUND HORIZONTAL ENGINE FOR ELECTRIC LIGHTING.

We illustrate below a compound horizontal engine which has been specially made by Messrs. John Fowler and Co., of Leeds, for Colonel North, to drive the electric light installation at his mansion at Eltham, Kent. The engine is of 25 nominal horse-power. The high-pressure cylinder is 10in. and the low pressure 16in. diameter by 20in. stroke, and the speed is 120 revolutions per minute. Both cylinders are fitted with Hartnell's automatic expansion gear, controlled by one governor, which ensures great steadiness in running. The flywheel is grooved to receive five 1¼in. ropes and is 10ft. in diameter. This engine is specially constructed for long runs, and has drop-sight lubricators to all the bearings and sight-feed lubricators on both steam chests. The cylinders are steam-jacketed throughout, and so proportioned that the work is divided equally between them, and the shocks to which an ordinary high-pressure engine is subject are avoided and great steadiness in work is obtained. To facilitate starting a valve is provided for admitting steam from the boiler to the low-pressure steam chest, which is closed automatically. By this means more than the ordinary power of the engine is available if wanted for a short time. The motion work is of best hammered scrap-iron, polished, and all the wearing parts are case-hardened. The crank-shaft is of hammered steel, with balanced cast-iron crank discs; the cank pins are of steel, forced into place by hydraulic pressure. The bed-plates are of cast iron, and of the deep box pattern, ribbed inside and flanged to provide large surfaces for contact with the foundations. The main bearings and slide-bars are formed in the same castings with the bedplates. The slide-bars are cylindrical and bored in line with the cylinders. The main bearings are fitted with large adjustable brasses of best gunmetal. Messrs. Fowler, we may add, were the first to apply the compound system to semi-fixed and fixed engines, and the success which has attended its application is shown by the largely increasing demand for compound engines.



Compound Horizontal Engine by Fowler and Co., of Leeds.

ELECTRIC LIGHTING AT TERNI.



The Combined Arc Light Dynamos and Turbine at the Terni Steel Works.

The above illustration, which we take from the *Centralblatt*, shows the nineteenth and twentieth dynamo and tenth turbine which have just been put down in the installation at the Terni Steel Works. The machines have been built by the Esslingen Maschinenfabrik, and, as will be seen, each turbine drives two dynamos. The total number of lamps now in use at these works is 160 arcs and about 1,000 incandescents. Power is obtained from the River Velino, 8,000 horse-power being available.

The illustration shows two 10-arc lighters with a 20 horse-power turbine.

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WOODHOUSE AND RAWSON UNITED (LIMITED).

An important amalgamation of electrical companies takes place this week in which are concerned the four Woodhouse and Rawson Companies and Messrs. Charles L. Baker, of Manchester. It may be recollected that Woodhouse and Rawson, who were one of the earliest firms to start in the electrical engineering business some time ago, formed different portions of their business into limited companies, their reason being, as we are informed, that in order to extend the business several partners were taken into these branches, which were then turned into limited companies to avoid unlimited liability and to define the rights of the several partners. Woodhouse and Rawson (Limited) was formed shortly after the well-known action with regard to incandescent lamps, and as the business had been much disturbed by the result of this action the directors paid nothing for goodwill or patents, except Founders' Shares, which entitled the holders to four-fifths of the profits after 10 per cent. had been paid on the Ordinary Shares. Now that the effects of the action have been got over and the subsidiary companies are also in a paying position the amalgamation of the whole of the interests has been effected. The combination obtains the services of Mr. Baker, who will take charge of the manufacturing department, and his well-established business is also absorbed. The combination has the advantage of a strong and practical Board, and from what we hear the Company seems to have met with considerable response from the public. No doubt the actual depositing by Woodhouse and Rawson (Limited) of £75,000, profits of the last year, which £75,000 is practically what the Founders' Shares of Woodhouse and Rawson (Limited) will be entitled to, has proved a great attraction, showing the confidence that the original proprietors had in the future of the new concern. On the whole we congratulate those interested in the business, and think that if the new company is carried on with the same energy as the old, there ought to be very good results to the new shareholders.

AMERICAN NOTES.

(from our own correspondent.)

New York, *July* 13, 1889.

There is no need to remind your readers of the fact that the Brush Electric Company is a pioneer in its field, and that with its name are associated some of the earliest and most striking triumphs in arc lighting development. Mr. Brush's originality has attracted notice abroad as well as at home, and the apparatus of the company was practically the first upon which large and enduring and successful local companies were established. As long ago as 1875, Mr. Brush's attention was occupied with the problems involved in electric lighting, and though of late years he has not been so prominently before the public, he has still been quietly and actively at work on one thing or another. The recent decision in our Courts with regard to Mr. Brush's early work in thestorage battery field, did much to fix attenattention on him again, and now he comes forward with another bid for public favour in the shape of a well-developed alternating current system, bringing his work and invention fully abreast of the latest theory and practice of the time. This alternating current apparatus, in the perfection of which Mr. Brush had the valuable assistance of Mr. Gustav Pfannkuche, the well known electrical engineer, is already being put upon the market, and thus, owing to the prestige which the Brush Company enjoys, together with its numerous footholds and the claims which the apparatus makes for superior economy and efficiency, it seems likely that it will soon occupy a prominent position. One of the most characteristic features of the system is that the alternating generator has a stationary armature which contains no magnetic material whatever, and which is so constructed that any individual coil may be cut out, removed, and put back again without stopping the machine. The field magnets revolve, being carried by the shaft. The machine generates a current of 2,000 volts. The converter used is not unlike the well-known Brush armature used in arc lighting. The core consists of a polygonal ring made of insulated iron wire of the best quality, so wound as to leave several concentric air spaces in the core. In the smaller sizes the core is built up of thin perforated iron plates. In both cases the iron is so divided, that the efficiency of the converter is little less with half load than with full load. On each side of the core is wound a single layer of heavy copper wire. Four or five single layers of coils carried by each half of the core are joined in series, and the two groups borne by the two halves of the core are joined in multiple, the whole constituting a secondary core. Most of the converters are wound for a secondary current potential of about 100 volts, but they may be instantly connected so as to give 50 volts. They are made in all sizes, ranging from 2 up to 250 lamps. Ventilation has been specially provided for in this converter, the insulation resistance is remarkably high, and it is said to be virtually impossible to so overload the primary so as to break down the insulation and short-circuit into the secondary. With regard to the performance of the alternating generator, a card is published which shows that the fall of the potential in the machine from no load to full load is less than 10 per cent. This result is reached without compound winding or artificial regulation of any kind, a result which is said not to have been approached by any alternating machine with iron core armatures. All the regulation needed is applied at the exciter, which is a small Brush dynamo of the old familiar type, accompanied by a rheostat worked by hand, or automatically, placed in shunt-circuit around the exciters' field magnets. It will have been noticed that the potential in this new alternating system, which represents the deliberate judgment of a corporation that is conservative as well as progressive is no less than 2,000 volts. I should not be surprised if some systems which have hitherto been contented with the lower voltage, say in the neighbourhood of 1,200, bring their standard up to the higher point thus fixed, in spite of the adverse clamour on the subject.

In view of all the agitation on the danger from electricity and the claims of sensational articles in the newspapers, it is a relief to find, from a table just published by Dr. Wheeler, of the Subway Board, that last year while there were no fewer than 1,258 deaths from accidents in this city, only five of these were due to electric shock, and if the investigations were carried a little bit further it would be found that even in these cases the "accident" was more a display of absolute, downright carelessness than anything else. Looking over the table, for example, one finds that although these wonderfully-dangerous electric wires run all over the city in every direction, and on some streets may literally be counted by hundreds, there were ten times as many deaths from the fall of heavy bodies, six times as many from falls through elevator shafts, six times as many at fires, nearly forty times as many from drowning, nearly seven times as many from gas, and just about as many from food. The table shows, in fact, that there were almost as many deaths from being "sat upon by father" as there were from all the electric light wires and plants in the whole of this great metropolis.

Such being the showing, one need not wonder that the various points involved in execution by electricity again come up for review, and that people should more and more incline to the opinion that it would be well not to employ the current as a means of capital punishment until more is known about it and its effects. As I wrote you recently, the judge before whom the appeal of the murderer Kemmler was heard, referred the matter for the taking of testimony to prove or upset the contention that electrical punishment was "cruel and unusual"; and during the present week the referee has been sitting in this city, hearing the evidence of a number of experts, including Mr. Harold P. Brown. The drift of the evidence was that although a good deal had been ascertained with regard to the effect of the current on animals, the results on human beings had not yet, so to speak, come within the category of *res adjudicata*.

The Thomson-Houston Company is feeling greatly elated over its recent good luck in securing the contract for the operation of the West End Street Railway Company's system in Boston by electricity. The arrangement is that the West End Company will purchase the poles and set them, and furnish current for propelling the cars, while the Thomson-Houston will do the entire electrical construction and supply motor trucks. The West End Company has already purchased a large building and intends to convert it into an immense power station of eight or ten thousand horse power capacity for supplying current all over its vast system. Of course, it is not to be supposed that

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the whole of this work will be done at once, but even if it be done in sections, the work of equipping one hundred cars at a time, and putting them into operation will involve no mean electrical engineering, especially in Boston, where the grades are often sharp, and where the crookedness of the streets is equal to that characteristic of so many of the thoroughfares in London.

An appointment just made by President Harrison is of some little interest. I refer to the appointment of Prof. T. C. Mendenhall, of Terre Haute, Ind., as superintendent of the Coast and Geodetic Survey. Prof. Mendenhall, who is an Ohio man, was Professor of Physics and Mechanics in Ohio University from 1873 to 1878. He then went to Japan as Professor of Physics in the Imperial University at Tokio. In 1881 he returned to the United States, and to Ohio University. In 1882 he organised the Ohio State weather bureau service, and devised a system of weather signals for display on railroad trains. He became associated with the United States signal service in 1884, and established stations in the United States for the systematic observation of earthquake phenomena. In 1886 he left the Government service to accept the presidency of the Rose Polytechnic Institute, of Terre Haute, Ind., a position which he still holds. At Terre Haute, assisted by Prof. Gray, whose brother is so well known in scientific work in England, he has done much to develope electrical studies, and has established a special course in electricity. Prof. Mendenhall is the author of a handy little book, entitled "A Century of Electricity," and he is also responsible for the electrical portions of the superb new dictionary of the English language now being published by the *Century* Company of this city. It will be seen, therefore, that President Harrison has made a good choice, and has recognised the claims of scientific attainment and experience.

The use of the electric motor for stationary-power purposes is rapidly becoming popular, and the system is already familiar to large classes of power users, who but a few years ago had as much idea of driving their machinery by moonbeams as by the electric current. The newspapers have done good educational work in this respect, and have themselves been remarkably prompt in appreciating the good points of the motor, and in adopting it. There are now large numbers of printing offices in this country where electricity is the only power employed. Even where it is not the intention to adopt electric power permanently, it would be an excellent resource in times of emergency. An episode that occurred recently at Washington illustrates this point. The *Star*, of that city, a large evening paper, suffered from the invasion of the Potomac floods, and had its printing office disabled by the falling in of the walls upon the engines. In such a pinch, and not desiring to be dependent upon the charity of neighbours in the matter of making its issues, the *Star* resorted to electric motors. The arrangements were readily carried out by the local electric light company. C. and C. motors were ordered by telegraph from New York, and in a few brief hours the motors were set up and in operation, giving the most satisfactory results. It is hard to think of any other way in which the newspaper could have tided over the difficulty, and anybody can see that such an accident as this not only makes a warm and powerful friend for the electric motor, but will do much of itself to satisfy printers that electricity is what they need.

An interesting controversy has arisen between the Western Union Company and the Postmaster-General with regard to the rates to be paid by the Government for telegraphic service. Ever since the time that the law regulating the matter was passed in 1866 a rate of one cent per word for dispatches of 20 words has been charged, and one cent for every additional word, with 10 per cent. added for distances over each one thousand miles. By dint of long usage this rate had become accepted as the standard, and the Western Union Company had taken it for granted that there would be no attempt to disturb it. The Postmaster-General, however, in filling out blanks for the fiscal year has made them out at the rate of one mill per word instead of the customary one cent, so that the company would get only one-tenth of what it received before. It can be readily understood that in the course of a year the Government business amounts to a tolerably large sum, and under the new conditions the Western Union Company would prefer to let it alone rather than do it at a loss. It seems, however, that the Postmaster-General is well within his technical rights as conferred upon him by the statute; hence, he is practically master of the situation. The Western Union Company are now discussing the matter with the Government, and hope to secure some modification of the new terms. Nobody supposes for a minute that the rate of one mill per word is anything like adequate compensation, and in some quarters there is a disposition to regard the action of the Government as significant of other movements in the same direction. This, however, seems hardly probable, as there is no vigorous sentiment in the country at the present time in favour of Government telegraphs.

In a previous letter I mentioned the movement toward consolidating the various Westinghouse electrical interests. It is now understood that the plan has been carried through, and that the stockholders of the Westinghouse Electric Company, at a meeting held at Pittsburgh on July 11, decided to reorganise under the name of the Westinghouse Electric and Manufacturing Company, employing for the purpose a charter of the Chartiers Improvement Company, granted as far back as 1871, conferring powers and privileges that cannot now be secured under existing legislation. Now that the new incorporation has been effected all the various Westinghouse interests will be consolidated into one, each constituting a department of the new business. It is stated that the company is now employing 2,000 men.

CORRESPONDENCE.

LIGHTNING PHOTOGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Of the many problems that await development and explanation, not the least interesting are those relating to lightning, and of several such we may mention the peculiar form of electrical display termed "ball lightning," and the curious "branch-markings" sometimes observed upon the bodies of persons said to have been struck by a flash.

These and many other phenomena, although unexplainable, are nevertheless accepted by scientists as verities. The views of scientists are not, however, always broad, for when we come to the reported phenomenon of "lightning photography," *i.e.*, the reproduction by lightning of the image or resemblance of some adjacent object upon the body of a person said to have been struck, the unexplainable is derided and thrown amongst the fictions.

It is this last-mentioned effect that I select for present remark.

Of several reported instances of "lightning photography" I quote the following:—

"September, 1825.—The brig 'Buon Servo,' in the Bay of Armiro was struck by lightning, and a sailor sitting at the foot of the mast was killed. Marks were found on his back, including the impression of a horseshoe, perfectly distinct, and of the same size as the one that was fixed to the mast."

"At Zante, the number 44, in metal, was attached to the fixed rigging between the mast and the cot of one of the sailors. The mast was struck and the sailor killed. On his left breast the number 44, well formed and perfectly identical with that on the rigging, was found marked. The sailors agreed that the number did not exist on the body before the man was struck."

"M. José Maria Don, of Havannah, states that in 1828, in the province of Candelaria, Cuba, a man was struck by lightning, and on his neck was found the image '*d'un fer à cheval que avait été cloué à peu de distance contre une fenêtre.*'"

This question of "lightning photography" was raised by myself during the discussion which followed the reading of Prof. Oliver Lodge's Paper at a recent meeting of the Institution of Electrical Engineers; and it was then demonstrated, in connection with my remarks, that a variation in electrical condition was always attended by a radiation of force. The sugges

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tion was also made that possibly the similar but vastly greater force radiated from substances under stress by lightning would be capable of effecting an electro-chemical change, such as was apparently needed in order to an explanation of "lightning photography," and moreover that where, in the case of flat surfaces, the lines of force would be parallel, there should be no difficulty in apprehending the possible formation of a mark bearing some resemblance to the object by which that force was evolved.

Of course unsupported theory is of small value, but it happens that a question then present to my mind has been experimentally asked and answered, and it is the answer that I wish now to give.

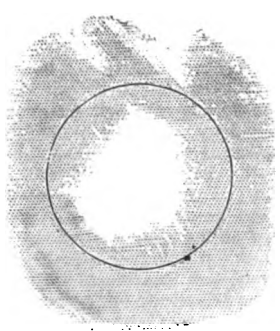
The question was: "If under such conditions as those just mentioned it be possible for lightning to effect such markings as those quoted above, then surely this same remarkable radiated force should have the power of also electro-chemically reducing potassium in saturated paper?"

In testing this question of "radio-chemical" effect a Ruhmkorff was used, the ends of the secondary coil being respectively connected to two flat metal surfaces. The two opposing surfaces were brought into juxtaposition, with sufficient interval between them to prevent sparking.

With this arrangement the radiatory and sonorous effects exhibited during the discussion already referred to were apparent.

A piece of clean blotting paper, moistened with potassium solution, was then laid upon one surface, and colouration by electro-chemical reduction immediately set in, increasing in intensity as the minutes went on, the raised parts of the uneven paper being the more quickly and darkly coloured.

The prepared paper could be laid upon either plate with a like result, as also if, insulated from both plates, the paper was simply suspended between them.



A piece of prepared paper, laid upon the centre of a piece of ¼in. plate glass, with one metal plate suspended over it, the other being abolished, was also coloured, although the period of exposure that was required for a given tint was very much in excess of that needed in the experiments previously mentioned.

Many experiments were tried, in which, whilst a piece of prepared paper lay upon one plate, a conducting substance of some particular shape was suspended over it, and it became evident that although outer edges and corners produced the more marked effects, the form of the inciting object would be distinctly discernable upon the paper. I submit herewith a few examples:—

No. 1. Flat surface, the size of a farthing; time of exposure three minutes; distance between it and opposing plate one and a-half inch.

No. 2. A circle; time, five minutes; distance, two inches.

No. 3. A circle; time, five minutes; distance, two inches.

No. 4. A circle; time, four minutes; distance, two and a-half inches.

No. 5. A circle; time, 10 minutes (very low power used in this case); distance two inches. (*See* Figure.)

This last is a very fine and beautiful specimen of form reproduction. Unfortunately some other good samples have faded too much to be of value. Example 5 presents a very uneven colouration, the unevenness being due to the difficulty in keeping the paper free from puckers.

To what then does this fact of chemical reduction by so-called induction bring us? I think it suggests that if with such comparatively low power we are able to accomplish so much, may we not reasonably believe that the sudden development of incalculable energy usually accompanying lightning will be well equal to the task of driving home with fearful intensity its radiated forces.

I think it may be claimed that, though all is not proved that may be desirable, we have, nevertheless, here recorded a feature which has hitherto apparently escaped notice, and which at the least should lift the question of "lightning photography" above the level of unscientific ridicule.—Yours, &c.,

ALEX. J. S. ADAMS.

A PECULIAR LIGHTNING SHOCK.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: An instance of a severe shock at the moment of a flash of lightning, and due apparently to induction, occurred here yesterday. The man injured was screwing up a nut securing a dynamo to its wooden foundation. The dynamo had no belt on nor its brushes down. It is in a low wooden shed, with a portable engine about five yards off. A pair of double rubber-covered well insulated wires are laid temporarily across the roof of an adjacent building for about 12 yards, and terminate in an arc lamp on the first floor. There is a telephone post near, 10 wires run nearly parallel and about 30 run across the electric light wires, about four yards above them. The lightning was thought to have struck one of the buildings near. No damage has been traced anywhere.—Yours, &c., W. H.

Leeds, July 24, 1889.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

June 21, 1889.

10,143. A. L. VOGEL. London. Improved means for operating electric light switches.

10,155. J. S. RAWORTH. London. Improvements in electric tram-cars and locomotives.

June 22, 1889.

10,173. J. NICKERMAN. Huddersfield. Improvement in stop motion for looms by electricity.

10,209. J. ZACHARIAS and F. MARX. London. Improvements in electrical accumulators or storage batteries.

June 24, 1889.

10,263. J. GARDNER and T. R. SOWERBUTTS. Preston. Transmitting signals to or from a locomotive engine by the aid of electricity.

June 27, 1889.

10,412. J. J. BUTCHER. United States. Improvements in electric railway cars, and in underground conductors and appliances for the same.

10,440. H. BAYLEY. London. Improvements in holders for incandescent electric lamps.

10,461. H. BROCKLEHURST and H. CONSTEIN. London. Improvements in electrical signalling apparatus.

June 28, 1889.

10,517. E. FRANKLAND, N. STOREY-MASKELYNE, A. H. HOUGH and D. G. FITZ-GERALD. London. Improvements in elements for voltaic batteries.

10,519. E. C. S. MOORE. London. Improvements in electro-motors (R. F. Moore, India).

June 29, 1889.

10,556. W. E. GRAY. London. An improved manufacture of flexible electric cable.

July 1st, 1889.

10,593. W. H. GRIMSBY and A. DOBRÉE. Stoke-on-Trent. An improved galvanometer.

10,597. H. J. GRISWOLD. Leicester. Improvements in electrical apparatus for lighting gas.

10,609. H. S. SCHULTESS-YOUNG. London. Improved method of automatic electric signalling on railways.

10,638. T. CASSON. London. Improvements in electro-pneumatic organs.

10,640. T. P. C. CRAMPTON and A. ESSINGER. London. Improvements in electric arc lamps.

10,641. W. E. GRAY. London. Improvements in the construction of underground conduits for electric conductors.

10,647. J. SHERRIN and J. V. SHERRIN. London. Improvements in the application of primary batteries and electro-motors to tricycles and other velocipedes.

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SPECIFICATIONS PUBLISHED.

1888.

9,745. MANVILLE. Electric motors. (Price 8d.)
11,100. KINCAID. Electric vehicles. (Price 8d.)
11,106. LAKE (Davis and Welch). Electrical signalling apparatus. (Price 11d.)
11,573. PYKE and BARNETT. Electric generators. (Price 8d.)
11,569. PIEPER. Secondary batteries. (Price 6d.)

1889.

135. TIMMIS. Electrically lighting, &c., railway vehicles. (Price 8d.)
898. HALE and others. Fire alarm, &c., telegraph. (Price 8d.)
7,129. HOWES. Arc electric lamp. (Price 6d.)
7,526. ALCOCK and GALOPIN. Electric arc lamp. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

The Eastern Telegraph Company (Limited).

The 34th half-yearly ordinary general meeting of the Eastern Telegraph Company (Limited) was held on Thursday, July 18th, 1889, at Winchester House, 50, Old Broad-street, London, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. George Draper) read the notice convening the meeting and the minutes of the thirty-third half-yearly ordinary general meeting held on January 24th, 1889.

The CHAIRMAN, having signed the minutes, and the report being taken as read, said: Gentlemen, it is a very full and instructive report, and I hope it will be to the shareholders a very satisfactory report. However, before moving its adoption I will, as I have always done on previous occasions, go over in detail some of the more important points which have occurred during the last six months, so that those who have read the report will more fully understand the results that are shown. The revenue account for the half-year ended March, 1889, shows a total amount from messages of £352,791, as compared with £324,144 in the corresponding half of 1883, being an increase of £28,647. About two-thirds of this increase arises from our South African traffic which has been favourably affected by the political disturbances at Zanzibar. Such disturbances where Governments are so actively engaged generally increase materially the telegraph traffic for a time. The very great activity which has been going on in South Africa on account of the gold mining operations there has also materially increased our receipts. I hope that it will settle down finally into a very satisfactory and permanent business. We are very sanguine that the trade established by those mining operations will, even in ordinary times, be a satisfactory one, and also a growing one, thereby increasing our traffic. Holding these views we have, in concert with the Eastern and South African Company, organised a complete system of telegraphy as an alternative system from the Cape to Europe by the West Coast. This growth of traffic has enabled the South African Company (the greater part of whose capital, as I believe you all understand, is held by the Eastern Company) to pay a largely increased bonus. The shares of the Eastern and South African Company being all but entirely held by the Eastern Company our revenue account shows that we have received as dividend from that Company £79,650, against £31,000 in the corresponding half of the previous year. This £79,650 includes an exceptionally large bonus from the South African Company for the whole year.

I am pleased also to remark that our Egyptian traffic, which has been steadily declining for some years past, shows an increase in the last six months over the same period of 1888, and so, if this small war that is going on now in Egypt continues, I think, when I have the pleasure of addressing you again, I shall be able to show you that war certainly does increase our traffic. I look for a still further increase in our Egyptian business.

One class of traffic alone, namely, the Indian traffic, shows a substantial decrease. This falling off, which in the past half year amounted to £5,550, is engaging our serious attention, but it is satisfactory to know that the decrease in the Indian traffic is more than counterbalanced by the growth of traffic in other directions. Our Black Sea dividend is the same as last time, and our investment in the Direct Spanish Company has given us £184 less than in 1888, that Company having paid a smaller dividend. Transfer fees show an increase of £25, and interest on money at our temporary disposal an increase of £1,095. To sum up, our gross revenue from all sources for the half-year was £435,932, as compared with £359,706 in the same half of 1888, being an increase of £76,226. The total working expenses for the half-year amounted to £92,448, against £87,134, or an increase of £5,314.

The details of increase and decrease are as follows:—General expenses in London were £7,988, against £8,333, or a decrease of £345. The working expenses at the stations were £68,545, against £62,786, being an increase of £5,759. As explained at the last general meeting this is in a great measure due to the increase in the number of our foreign staff, owing to the opening of the triplicate cable from Porthcurnow, Lisbon, Gibraltar, and Malta, and the extension to Zante on which the duplex system is worked, also to the opening of the new station at Cadiz, we having put that place in telegraphic communication with Villa-Real and Gibraltar. It has also been necessary to augment our staff at our other stations to enable us to carry with accuracy and despatch the additional number of messages. As compared with March last year the total increase in the number of our staff at our stations is 41. The increase in our travelling expenses was £750, rent, fuel, and light, £143, and stationery and printing £952, these increases being accounted for by the reasons just given. The other principal items of increase are furniture and fittings, £1,601, and repairs to stations £834. To meet the requirements of the traffic we have found it necessary to add to the accommodation of several of our stations, more particularly in London and at our training school at Porthcurnow, also at Carcavellos, Malta, Alexandria, Suez, Syra, &c. On the other hand, there is a decrease of £1,132 under the heading of maintenance and renewals of electrical instruments and appliances. £1,000 of the total increase in the working expenses is explained by our having carried £5,000 to the general ships' reserve fund, against £4,000 in the corresponding period of 1888. The expense of the issue and the stamp duty on the new capital, £817, also appear in our revenue account this half-year. Repairs to cables amounted to £48,655, against £38,412, or an increase of £10,253. On reference to abstract "C" in the report, full details of the work performed by our ships will be found. It will also be found that the expenses of five ships are included this half-year against four in the same period of 1888, the steamship "Amber," built to replace the "Volta," having been busily employed during the six months under review. The cost of 203 knots of cables used on repairs and renewals (the greater portion of which was used in the extensive repairs to our No. 1 Aden-Bombay cable) is also included. The total increase in our revenue has enabled us to meet the additional expenses incurred during the half-year, and we are going to pay an extra ½ per cent. bonus on the Ordinary shares, including the 20,000 additional shares issued to enable us to take up a like number of Ordinary shares of the Eastern and South African Company.

We have placed also £118,000 to the general reserve fund, against £75,000 last year. The reserve fund with interest received on investments during the half year, the premium on the issue of new shares, the profit on the sale of Direct Spanish Debentures, and the contribution from revenue account of £118,000 for the year ended 31st March, 1889, now amounts to just over half a million sterling. When I mention to you further that as you will see in your accounts, we have out of reserve and revenue spent £782,383. I think I need not make any other remarks to prove to you that our position is a most satisfactory one. Our object is to keep down the capital as much as possible; at the same time to maintain such an efficient system as will command the support of the public, and lead to still further development of the telegraph system.

I have now I think given you a carefully prepared statement of everything that has occurred during the last year. It has been our wish that the shareholders should know everything that we are doing when we have completed the work, and having informed them thoroughly of what we have done we expect from them approval of our work when we can show that it has been satisfactorily done. That brings me to make a few general remarks, and they apply more particularly to the work which we have just completed. I think when I had the pleasure of addressing you last—and it will be in the recollection of many persons—I said we were engaged in a very great and important work—that was, in laying and completing a system of submarine telegraphy round Africa by the West Coast, having already done so by the East Coast. That work we have just completed, and I am glad to say that in the completion of that work we have probably done the biggest and most important work yet done in submarine telegraphy. I may tell you that to complete the surrounding of this great African territory—the country, as many people think, of the future—no less than 17,201 miles of submarine cable have been laid, so you will see we have, at all events, done our part in enabling those who have enterprise to go on and develope the great material wealth of that country. It could not have been done excepting by organisation. We saw in early days that unless something more was done by the West Coast the two or three existing companies could do no good whatever. We also felt that the traffic to the Cape was such that it was important for us—in fact it became a necessity either to duplicate our system by the East Coast, or to lay an alternative line to the West Coast. We found that the laying of an alternative line meant first, security; and secondly, it enabled us to largely increase our telegraphing power, and to open up countries which had not been touched before by the submarine telegraph system. Two or three companies were engaged in that work, we having succeeded in getting them to take very much the same view as we ourselves held. When I last addressed you I asked you to help us by subscribing £200,000 to enable us to take up a like amount of South African Company's shares, and I may add that it has been a very profitable investment indeed; and when I tell you that England, Portugal, France, Spain, the Cape of Good Hope, and Natal are all more or less directly interested in, and have given support to this great enterprise, I think you will see that it has been done under such auspices as should secure permanency to it in the future. More than that, it has given what we have always desired should be given to our system of telegraphy—it has given an international character to it, because all the nations in Europe—in fact, all the civilised nations of the world—recognise now that it would be impossible to live without our submarine system, which brings them immediately into communication with one another. I think that that is a most important point to draw your notice to to-day.

In reading my first remarks I referred to the Indian traffic going down. It is a remarkable fact that during the last fifteen years, while we have, I may say, increased the volume of our traffic by 300 per cent. we have not increased our income by more than 100 per cent. That shows you that we have very clever people to contend with. I do not blame the merchants for codifying, but they have got it to such a state of perfection that even with the increase of trade—the large increase of trade—they are able to conduct their telegraphic correspondence in such a form as largely to reduce the words employed in each telegram. I confess to you that if I were a merchant I should do the very same thing; but I want to say to these merchants that they must take care not to put the screw on too much. There is some talk about the next conference moving to reduce the rates. We cannot reduce the rates unless we can increase our traffic and our income. We shall take very good care of our shareholders in that direction. What we desire is not large dividends, but certain dividends and the dividend we are declaring to-day I think must be

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generally accepted as a fair, satisfactory, and a good dividend. That will be the object we have in view.

Notwithstanding what I call the very encouraging prospects and the solid position of this Company, we have a deal of work before us yet. Some of our cables are getting old. We want to increase our capital as little as possible, but we must be provided with new cables to take the place of old ones when they die out. We are looking for a very large increase in our Australian traffic, and very probably we may make a reduction in the rates; but we shall take care, before we make any alteration in our Indian tariffs, to see our way very clearly. We have a cable from Aden to Bombay which requires very special attention, and if the traffic increases as we expect, and as it is doing, with Australia and other parts, we shall require to put down another cable to give us perfect security and safety, not only between Aden and Bombay, but Marseilles and Egypt. I merely foreshadow these things to show you that while we are earning very large sums of money we have very important work to do to maintain that income; but it will be our mission, and our warmest and most earnest interest, while we are adding to the value of your property, and not materially increasing our capital, to maintain the same satisfactory dividend as we have the pleasure and honour of proposing to-day. With these remarks I beg to move:—

"*That the printed report and accounts of the Directors, to the 31st March, 1889, submitted to this meeting, be and the same are hereby received and adopted; that a dividend on the Preference shares of the Company to 30th June, 1889, at the rate of 6 per cent. per annum, be paid, less income-tax; and that, in accordance with the Directors' recommendation, a dividend be and is now declared of 2s. 6d. per share, with a bonus of 3s. per share, both free of income-tax, on the Ordinary shares of the Company,, making with previous payments by way of dividend on account, a total payment of 6½ per cent. on those shares for the year ended 31st March, 1889.*"

The MARQUIS of TWEEDDALE: I beg to second the motion.

The CHAIRMAN: If any gentleman desires to put any question I shall be very happy to answer it before I put the motion.

Mr. FIELD: I should like to ask a question of Sir James Anderson—whether he would state what is the length of life of a cable?

The CHAIRMAN: I wish you were able to tell me.

Mr. FIELD: I put this question because it was the creation of Preference stock of £700,000 to duplicate the Bombay line that gave opposition. If we are to face an expenditure of anything like £700,000 again to triplicate the line it would be a very serious consideration. You foreshadowed that the day would come when it must be done. Is it contemplated to pay the cost out of revenue, or would there be a creation of capital for the purpose?

Captain GOODSALL: You mentioned that 203 knots of cable have been used in repairs. Is that old or new cable?

The CHAIRMAN: We never think it wise to put new wine into old bottles. A ship always carries a certain amount of new cable. If the cable that we pick up is in fit condition we bring it home, examine it, and recoat it, and if it is cable that we can use we re-lay it.

Captain GOODSALL: Then it is laid as new cable and charged as new cable. You say it is re-coated and relaid, is it charged to the Company then as new cable?

The CHAIRMAN: Have you any other questions?

Captain GOODSALL: Kindly answer that question first. You said the cable you bring home is re-coated and relaid, if thought advisable to do so. It cannot be new cable and be relaid.

The CHAIRMAN: Will you finish your speech and then I will answer you? There are other gentlemen waiting to address the meeting.

Captain GOODSALL: Will you tell me the number of months for which this £1,512 for the expense of the "Chiltern" in dock in London was for? You say in the revenue account "expense of the 'Chiltern' in dock in London." When did the "Chiltern" leave London, or has she left London?

The CHAIRMAN: Will you please go on?

Captain GOODSALL: You will answer these questions?

The CHAIRMAN: Oh yes.

Captain GOODSALL: At your last meeting I drew attention to the exorbitant expense for advertising. I see it is reduced by £100. I think it may be reduced a great deal more. You have no great competition. You are joined with most of the cable Companies. Why should you spend so much money in advertising? It is not necessary. There is, too, only one paper which you advertise in, and I think these expenses might be reduced considerably.

Mr. HURST: I have been a shareholder for many years in this Company—I think almost from its commencement—and I have watched its progress attentively and carefully, and I must say that all that I have seen, and all that I remember respecting the management of this Company has been in the highest degree satisfactory. You have gone through the report and accounts, and we have also had a good and excellent explanation from the Chairman of all the various items of the accounts. They all seem to tell extremely favourably, I think, and there is one point I should very much congratulate the Company upon, that is the care taken by the Directors to put our system on a solid and firm foundation. This is clearly proved if you look at it from the point of view of the amount of the reserve fund. You find that to the general reserve fund (and there are other reserves) no less than £118,000 is put for the past year. Well, this gives a degree of security that must be satisfactory to everyone. There is another circumstance very favourable to the Company, and which must give us great satisfaction. It is this—that when we were not receiving the dividend which we are now receiving, that is, when the Company was in a different state from what it is now, the Chairman and Directors did not buoy us up with any fallacious statements. The statements were clear, and when we received only 4 per cent. they did not calculate and hold out any expectations that we should receive the amount of dividend that we are now receiving. The bonus is also very satisfactory. The growth of the Company is one of the most marvellous things of the world. Our system goes to every quarter of the globe, and its growth every year is one of the most marvellous things of the present age. I think we may express ourselves extremely satisfied with the way the thing is worked, and I have no doubt that we shall still year after year have as good a dividend and as good prospects before us as we have at present. The Company seems on so firm and so solid a foundation, that I think there is no doubt whatever of its continued success and advancement.

Mr. MILLIGAN: I had wished to ask one question on behalf of friends in India and Ceylon—whether there was any possibility or likelihood of a reduction of the tariffs there? Your remarks are eminently satisfactory and encouraging on every other subject, though they are rather discouraging on that one. I should like you, if you were able, to give some hope of a reduction of these tariffs ere long, because I am told that the present rates are prohibitive, and that, therefore, the people resident in the East adopt the codes to which you referred in order to reduce the expense of telegraphing messages. I would only quote the great example of the Post Office to show that a reduction in the tariffs may result in a great increase of revenue, and I think it would be the same in our case if you were able to reduce your charges to Ceylon and the East. I made the suggestion before knowing how well the interests of both the shareholders and the public are considered. I would take the opportunity of alluding to the invitation you make to send you proxies. It is a course that may be very desirable where there is as sometimes happens a conflict of opinion between the shareholders and Directors. That, however, is not the case here, and it is not likely to be the case, and therefore the issue of proxies seems to me unnecessary. Our meetings are so very harmonious that I think it would be found advisable to stop the issue of proxies.

Dr. WALLER: I merely rise to say that I think it will be much better for us to reserve any further observations until you answer the remarks that are now before you.

The CHAIRMAN: The first question, I think, was as to the life of a cable. We at one time thought that ten years would be the life of a cable. I have heard people assert—engineers and practical men—that a cable may live ninety years. We have repaired cables that have been down for fifteen, sixteen, or twenty years, and they seemed to be in very good condition. A great deal depends on where the cable is lying. If it is lying on a mud bank or gravel bank, where there is little friction, and where there is no suspension of any kind, the chances are that cables live for a very long time. If they are in a current or in any position where there is a great deal of friction, the life of a cable is materially shortened. It is just one of the features connected with submarine telegraphy that we cannot tell what the life of a cable is; but we know the value of telegraphic communications, and with an increased traffic we are bound to be prepared in the event of a cable giving out. We must then have duplicate, and in many cases triplicate, lines. The real purpose of telegraphy, to be beneficial, is that it must be continuous. Trade is being conducted almost entirely by telegraphy. The operation begins with a telegram and is closed with a telegram, and therefore we must have no interruptions, because if we had interruptions confidence would cease.

The next question is from Captan Goodsall, to whom I referred at our last meeting. Captain Goodsall has put a question which I think, if he had been watching and observing, he might have satisfied himself about without coming here to make the inquiry to-day, as to where the "Chiltern" is. I should have referred to the "Chiltern" in my opening speech. The "Chiltern" has been employed in the last few days in completing a contract with the French Government for laying a cable from Perim to Obock. We have, in the last two days, exchanged telegraphic congratulations on the successful laying of that cable, and for that contract we shall receive something like £1,500 per annum. It is a small capital; so you see the "Chiltern" has been very usefully and satisfactorily employed. She is now about to relieve the ship bearing my name, and that ship will return to London.

As to "re-serving" for cables, that is another question, which, as a matter of detail, belongs to the experts of the Company; but, as I said, when we pick up a cable, if it is good enough to re-lay it, we do so; but we do not charge anything but the cost of re-coating. We do not put it down as new cable. We utilise these cables in short lengths and in shallow water, and where we find they come in at times very usefully.

As to the question about advertising, if you look at other companies, and compare our Company, which is a company of six millions, you will find that our advertising expenses for the six months have been £450, I think you will admit that it is necessary to keep ourselves before the public in a certain way, and that is a very small sum. (Hear, hear.) I think many of the companies you see advertising spend three times that amount. However, the point Captain Goodsall is aiming at is this, and I stated it fully before, and there is not much use in my repeating it again—£130 of that amount is for *The Electrician*. *The Electrician* belongs to myself and a few other gentlemen who are interested in electricity. I told you last time that we had not started that paper for the purpose of getting money out of it. We have never taken a shilling profit out of it. We pay a high price to the men who write the scientific articles, which are of a very high class, and we send *The Electrician* to every station, so that our young men, who are to be the men of the future in electricity, may know everything that is going on about it. There is nothing I am more proud of than the way in which *The Electrician* is conducted. It is a high-class paper. We have the very best scientific men writing for it, and all that is done for the benefit of our staff and the public who are interested in a faithful and unbiassed record of everything relating to the progress of telegraphy and electricity. It is not carried on for the purpose of putting money into our pockets. (Cheers.)

Captain GOODSALL rose again to address the meeting, but

The CHAIRMAN said: You have spoken, and I will not answer you further.

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Captain GOODSALL: You said you would answer all my questions. I asked how many months this £1,500 represented for the "Chiltern" in dock in London.

The CHAIRMAN: I think I must now make a statement again. I thought the gentleman who has just been addressing you had more taste and more respect for himself than to force me to make this statement. He has come forward to-day with very frivolous questions—so frivolous that I am exceedingly sorry that he should ever have been an employé of this Company. He is not so now. As I said at the last meeting, and as I say now, he left the Company for the Company's good. I am sure the shareholders will not listen to a man who comes here to put questions as to which there is no point or purpose, but simply, as he supposes, to give us annoyance.

Captain GOODSALL: I have asked a simple question—why do you not answer it?

The CHAIRMAN: I think I have replied to the gentleman who spoke about the reduction of the rates. We have had no recovery at all for the reduction we made in the Indian rates some time ago; in fact, the reduction in those rates has caused the traffic, instead of growing, rather to fall off—not that the trade has gone down, but that the cleverness of the merchants enabled them to conduct their business with fewer words than before. I have had a great deal of experience in mercantile life, and if you were to ask some of the merchants you would be astonished at the enormous amount of matter which they put into two or three words, and after all these two or three words amount to a comparatively small sum. If we were earning now what we believed we should earn when we put out our first prospectus, we should be earning over cent. per cent. The merchants have been so keen that I do not see where we can reduce our charges. At the same time, if we can see that we can do so, we shall be only too glad to reduce the tariff. So far, however, the reduction of the tariffs has not increased our earnings, but rather the reverse.

Mr. MILLIGAN: I will convey your remarks to my friends.

The CHAIRMAN: As to the question of the proxies, we have 7,000 shareholders—the Secretary tells me that we have 10,000, which shows how popular our Company is. Now there are here to-day probably 100 persons. Many of the shareholders cannot come here; they are scattered all over the kingdom. Would it be just to them to be unrepresented at these meetings? We do not charge the Company with the cost of the proxies. We send them out to the shareholders who cannot attend, and only to the shareholders who hold 100 shares or more. We do not send them to small shareholders. The Board pay for the proxies themselves in order that those shareholders who are absent may be represented. I think I have replied to all the questions that have been put, and I hope in a satisfactory manner.

Captain GOODSALL: You have not answered my question.

The CHAIRMAN: Those in favour of the motion please to signify the same in the usual manner. To the contrary. The resolution is carried unanimously.

Captain GOODSALL: Why do you not answer my question?

Dr. WALLER: Placed in the disagreeable position that you are in, it is as well that I did not speak; but I had intended to speak before the resolution was passed. The observations I should have made would now perhaps be irrelevant. I will, therefore, only say that I am very glad indeed that I desired the questions which had been put should be replied to before we proceeded further. The answers have been just what I and everyone else expected. I think the shareholders will agree that this gentleman has enlivened our meeting to-day as he did on the last occasion. I had intended to make some other observations, but I will say nothing further now.

The CHAIRMAN: That is all the business of the meeting.

Dr. WALLER: There is one thing I wish to say, however it may meet the views of others. I have often been told this—"Telegraphs are very good while they last, but do you not think if one of the nations were at war with England the telegraphs would be cut?" The observation you made to-day is a great answer to that. You told us that in submarine telegraphy there is now international co-operation. From the moment that has been so no country will cut the cables because they would be cutting them against themselves. And I shall be able to make that answer to those who tell me that the cables will be worth nothing in the event of war. "Yes," I shall tell them, "they will be, because all the parties are interested in keeping the cables going."

The CHAIRMAN: The business of the meeting is at an end, gentlemen.

Mr. JOHN NEWTON: I have much pleasure in rising to move a vote of thanks to the Chairman and Directors. I do so because I have been in the past one of the most persistent critics of the Chairman. I may say a few words as to this gentleman who interrupted the meeting with entirely personal questions.

Captain GOODSALL: Not at all.

Mr. NEWTON: The questions he put did not arise out of the business of the meeting. I have interrupted the meetings of the Company in times past with personal questions, but the personal questions I have raised have always been on the immediate action of the Directors to the shareholders, and to me in this room. This is entirely an administrative question as between the directors representing us and an old official of the Company, I claim that no past official should continue to interrupt these meetings by such questions, because, bear in mind, they are not questions put in the sense of enlightenment to us, but questions put in order to make a statement of a personal grievance. We should be very delighted to hear him, perhaps, for, as one shareholder said, he has enlivened the monotony of our meetings—a monotony arising from our success. There is no doubt, however, that the success of the Company should prevent you from hearing questions of that kind. There is only one little point on which I disagree with the Directors—that is as to issuing a fresh class of stock. I have a strong opinion on that matter, and when the time arrives I shall make known my views. I rose, however, to propose a vote of thanks to you, as you are entitled to congratulation on the great success of the Company. When you can issue your shares at a premium and put out Four per Cent. Bonds at par, as you do, there is nothing to be said. I only hold one share in this Company, but I am interested in the Globe and the Eastern Extension. I beg to move a vote of thanks to the Chairman and Directors.

Dr. WALLER: I beg to second the resolution.

The SOLICITOR (Mr. Burt): Gentlemen, it has been moved and seconded, that the thanks of the meeting be given to the Chairman and Directors for their satisfactory management of the affairs of the Company during the past year, and to Sir John Pender for the satisfactory way in which he has conducted the business of the meeting to-day.

The resolution was carried.

The CHAIRMAN: I beg to thank you, gentlemen, on behalf of myself and my colleagues. We have, I am sure, tried to deserve your confidence, and I am very pleased to see to-day that we have got it.

The proceedings then terminated.

The Anglo-American Brush Electric Light Corporation (Limited).

An extraordinary general meeting of the shareholders of this Corporation was held at the Cannon-street Hotel on the 22nd inst., under the presidency of the Lord Thurlow.

The MANAGER and SECRETARY (Mr. E. Garcke) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I can only say it gives me great pleasure to come here to-day with the programme in our report to explain to you. It is a programme that has been compiled with a great deal of care and deliberation, and I am bound to say that it consults, in my opinion, your interests most closely, and I think I may say on behalf of every member of this Board that we consider that it cannot do other than very greatly advance the value of the stock you hold, and that on the other hand if you do not pass these resolutions and adopt the course we recommend we consider you will be standing entirely in your own light. The report is very exhaustive, and, I think, gives you particulars on every point, and I do not think it will be necessary to repeat what it contains. It divides itself or may be divided, roughly speaking, under five distinct points, all of them of very great importance. The first deals with the question of litigation, which I am thankful to say is happily at an end. The second point deals with the reconstruction of the Company, which it was not possible to proceed with until the important question of litigation, and especially the Edison and Swan litigation, had been satisfactorily settled. The third point is the amalgamation with the Falcon Company. The fourth point relates to the proposed amalgamation with the Australasian Company; and the fifth point which I desire to call your attention to a little later on is the prospects of the reconstructed Company, which is, after all, the absorbing matter to us. Now, first as regards litigation: that is under two heads. There is the Edison and Swan litigation, which has been a source of tremendous anxiety to us for the past two or three years, and not unnaturally so; and I believe it has been of equal anxiety to the Edison and Swan people. That has been, a matter of practically vital importance to the Corporation. Besides, we have a smaller action still pending with regard to the compound winding of dynamos. That is a matter of practically such trifling importance that I do not think it is necessary to say more than a few words with regard to it. In the case of the Edison and Swan, the settlement we have arrived at, and which could not have been arrived at without a great deal of mutual compromise, I maintain is, if not quite as favourable as any of you might yourselves dictate, practically as favourable as it was in our power to secure. We had the alternative of proceeding to the bitter end. We had the alternative of going to the House of Lords, which we had expressed our intention of doing. That, however, would have been a very serious step. I think, indeed I know, that the majority of this Board and a very large number of the shareholders were of opinion that if we had gone to the House of Lords we should have won our case. But there is always some uncertainty in legal proceedings, and there is a possibility, greater or smaller, that we might have lost the case, and had we lost it I have no hesitation in saying that the position of this Company would have been desperate. The damages would have been excessive. We should have lost, and I think justly lost, the confidence of the shareholders, which we have hitherto possessed to, I think I may say, such a great extent, and for which we are duly grateful. I have myself felt, and several of my colleagues have felt, that had we pursued that obstinate policy, and fought this matter out in the House of Lords, in the event of its going against us the doom of this Corporation would practically have been sealed. We did not feel it wise to risk that, especially when we had gentlemen representing the Edison and Swan Company—who, after all, were reasonable men—who also deprecated final resort to the ultimate Court of Appeal. The result was we agreed upon the terms you are aware of, and under these terms honour is saved on both sides. The valuable patents of Mr. Lane-Fox are not only maintained, but the Edison and Swan Company take a license under them, and recognise their validity. On our part we give up manufacturing the lamps, which, up to this time, whatever it may be in the future, has not been a source of very large profit. We are to get lamps from the Edison and Swan Company on the most favoured terms, and they are to pay us a royalty. I hope that, having regard to the whole circumstances of the case, and to the very large issues involved, you will agree with me that we have acted wisely on this occasion in preferring half a loaf to the chance of no bread at all, and in making the terms in respect to both parties which we have made with the Edison and Swan Company. One word about the other litigation—the compound-winding litigation, which I said just now was a comparatively trifling action; and so it is when I point out to you that it stands to us in a very different position from that in connection

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with the Edison and Swan Company. In the Edison and Swan action they came to us for damages for, as they contended, infringing their patents. We had a counter action, but that does not matter. They came to us for damages, and if we had lost that action we should have had to pay most exemplary damages. In the compound-winding case it is the other way. We hold that they have infringed our patents, and if we win we shall get exemplary damages from them. Then the costs of conducting this action—the compound-wound action—are trifling compared with the gigantic expenses of the Edison and Swan case. For that reason, and because we are advised we are in the right, we have given notice of appeal against the decision of the Scotch Court. You are aware that the decision in the English Court was in our favour. In the Scotch Court it is adverse, and we have now the Court of Appeal. The position of the Patent Law with respect to England and Scotland is one that is recognised as anomalous, and I think I am not far wrong in saying that some remedy for the existing state of things in this matter will not be long delayed, and when Scotch and English Patent Law will be put on a satisfactory footing. The loss of our case which we have sustained in the Scotch Court is due, I think, to the anomalous position of the law at present. That is all I have to say on the subject of litigation. I now come to the perhaps more interesting subject of the reconstruction of the Company. One or two shareholders have asked if it was necessary to reconstruct the Company. I can answer that question very simply. Every company has, as you know, Articles of Association, and what is more a Memorandum. You can alter your Articles of Association, but not your Memorandum, and our Memorandum is not wide enough to enable us with perfect legality, according to our careful lawyer's opinion, to embark in engineering business. You also know that engineering business occupies now almost the lion's share of electrical work, and to separate the two things is commercially impossible. When this Memorandum was drawn up that was not foreseen, not fully realised, and that being so it was necessary for us, to enable us to compete with them upon equal terms—it was necessary for us to have an absolute legal basis to work this extended business upon. At present the frames, the heavy casting of our dynamos, we have obtained from various founders; the engines also we have had made outside. With these works we propose to acquire we shall do away with the middlemen and get the profits by so doing. I say again, if we did not do so we could not compete on equal terms with the firms which are about to do this business. I think that will be a satisfactory reason, at least it is a compulsory one, for winding up the Company and forming a new one. There are other reasons behind, and advantages which we can gain, by winding up this Company and forming a new one. We can, for one thing, divide our capital in a more satisfactory form. We can have Preference Shares and Ordinary Shares, and it is proposed to give for each share held by you up to the present moment one Preference and one Ordinary Share. That will enable us in bad times almost to secure, I think, to you the certainty of a good dividend on your Preference Shares, and I also hope—and I hope not without a considerable amount of reason—that you will have a handsome dividend on your Ordinary Shares, perhaps after the first six months' working. Everything is in our favour in the formation of a new company. We shall have all the experience of the past. We have our old well-trained staff, whose names have become household words, I venture to say, in the electrical world, and at the same time we shall have all the energy and "go" of a new concern. There are other minor points which render it desirable in amalgamating, for instance, with the Falcon and Australasian Companies. It is easier to effect terms, and more favourable terms, starting afresh and with a new company than if we were grafted on the old company. Everything therefore, in my opinion, combines in our favour. Several letters I have received from the shareholders have approved one proposal that we have made, and that is calling up the £1 which is not paid on some of our shares. I think they are very wise in approving that course. I hold some of these shares myself, and I agree that it is wise to call up that £1 upon the shares which will then become equally saleable in the inevitable "boom" that is going to take place in electrical shares. That is, perhaps, sufficient to say at the present moment about amalgamation, though, as I said at the outset, I shall be happy to answer as fully as I can any question that may be asked of me. With regard to the Falcon Works at Loughborough, they have been visited by several of the Directors. We have taken experts to them, and it is a dividend-paying concern. So far as we know, everything is in its favour. It has the reputation of having turned out good engines, and its machinery is all erected on approved principles. It contains a certain number of acres of freehold land remarkably well situated with respect to railways and canals, and it will enable our works practically to permit of indefinite extension. It is proposed as a matter of fact to enlarge the works almost immediately, and plans are being prepared for so doing. The enlargement will not be very expensive. The acquisition of the Falcon Works, too, solves a question which has been occupying us for the last two years—the question I have spoken of more than once—of whether we should leave London and go into the country, or whether we should increase our works in London. It has solved that question by dividing our work into heavy and light, and perhaps the greater part of our light work will continue to be done at Belvedere-road, where the works are eminently suitable for our requirements. We could not leave these works without entailing on us very heavy expenses, and these works are very valuable to us as a place to show to gentlemen from the Colonies and abroad who come here with large orders to place. For that reason we retain the Belvedere Works, and a more beautiful set of works and more beautiful machinery than they now contain it would be difficult to find. The Falcon Works at Loughborough will be our mainstay for heavy work and the manufacture of the motors and other things. That being so, I will ask you to-day, if you approve generally of the programme we lay before you, to consider the purchase of these works on the terms indicated as sanctioned. It will not be in our power to ask you to pass special formal resolutions on account of the omission as to engine business in our memorandum. For that reason it is not possible as a technical point for this Company to acquire the Falcon Works, but I ask you to sanction this in a formal manner so as to enable the new Company to acquire them. As to the proposed amalgamation with the Australasian Company, the acquisition of the assets and business of our sub-companies has been in our minds for years. It so happens that Australasia is making very rapid progress in electrical science; indeed, it is certainly in advance of England and of several Continental countries. The Australasian electrical business for the next few years promises to be exceedingly large, and I have no hesitation in saying that the Australasian Company is not in a position at the present moment to reap the utmost advantage from the anticipated increase of business. Perhaps one of the reasons they came to us and that enabled negotiations to be satisfactorily carried on was owing to the circumstance that a large number of the shareholders in the one company held shares in the other, and it is their mutual interest to see the two companies working together. Without that circumstance I feel sure we should not be able to arrange satisfactory terms, and I hope there will be no hesitation on your part, or on the part of any of you, to sanction the contemplated agreement with the Australasian Company I shall have to put before you to-day—hardly in final shape, for this, that there are one or two questions not yet settled. I shall therefore ask you to accept the agreement with or without modification, it being understood that there will be some modifications. That I think is all I need say about the Australasian Company. As regards the prospects of this Company, I think if you pass these resolutions our future is practically assured. Electric lighting and electric work generally are in a very different position from what they were two or three years ago. The best proof of that is the readiness with which capital is subscribed in England for these large undertakings, and it is only by bringing a large company into existence, as this will be, that we can hold our own in the electrical world. This is a way of doing that in a manner that should be satisfactory to all concerned, and there is no "watering" of your capital. Electrical companies have grown wiser by experience. You no longer see enormous sums of money given for patents, and there is no fear now of any capital you subscribe being absorbed in that direction. You may say that electrical companies now have sown their wild oats and addressed themselves to paying business, which is to become a recognised business like any other in the City of London, and I know of no reason why it should not be equally remunerative. If the new Company does not pay a dividend in the first six months I shall not venture to come before you. I pledge myself, in fact, that it will pay a dividend, and if it does not I shall disappear, because I shall consider that I have led you astray. I am very grateful to you for the confidence you have placed in me as chairman during the last few years. Without it we could not have surmounted the difficulties and anxieties in which we have been placed. As regards the Board, it is not proposed to largely increase their number. The Board at the present moment is not a large one. It was larger formerly. The vacancies have not been filled as they have occurred. The Board now is a small one, and not too large for its present requirements. It will be desirable to increase it by two members—one representing the Falcon Works (that is agreed on) and one representing the Australasian business. Beyond that I think there will be no intention to increase the Board. I do not propose at the present time that the Board should be increased—I venture to say that because I have received two or three letters from shareholders who expressed a hope that the Board will be kept within moderate limits. Before I put these resolutions I will now ask you to state frankly any objection that you may have to the course we propose.

Mr. MARKS desired the Chairman to give an undertaking on the part of the Directors that the unallotted part of the capital would not be sold under par.

The CHAIRMAN: It is illegal to do so.

Mr. MARKS: But by paying a larger amount of commission you might do so.

The SOLICITOR (Mr. Renshaw): You cannot issue shares at a discount now.

Mr. MARKS (continuing) asked if any debts of the Australasian Company had to be taken over. He also inquired the total law expenses, and whether there was almost a certainty now that the expenditure would cease.

Mr. LANE-FOX said he wished to take that opportunity of repudiating the idea that the Edison and Swan Company were entitled to the sole right to manufacture incandescent lamps. He wished to let it be clearly understood that he did not consider himself bound by the agreement or compromise which the Brush Corporation had entered into. He considered the incandescent lamp a matter of vital importance to the progress and welfare of electrical industry, and that it would be a very serious disadvantage to the prospects of the industry if the manufacture of the lamp were to be in the hands of any one company. After the important judgment of Mr. Justice Kay, he did not consider himself bound to leave the manufacture of the lamp solely in the hands of the Edison and Swan Company. He intended, as soon as he could get an opportunity, to himself start manufacturing, and he thought it important that he should make that announcement. With respect to the merits of the compromise, the Chairman had stated that it was the best possible arrangement that could be made under the circumstances; but the circumstances were very peculiar owing to this, that the Directors of the Brush Company had been under two fires as it were. They had been in antagonism with himself, while at the same time they had been opposed to the Edison and Swan Company. To one party they had said that his (the speaker's) inventions were of the utmost importance, and that they were anterior to anything that the Edison and Swan Company did, while to himself they had said that his inventions were of no importance at all and

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that they had lost money by them. He might say as to the Falcon Company that it seemed rather strange to him that a company that was going down hill, paying less and less, should be bought up at par, and he did not know why locomotive-building works should be specially adopted for electric lighting works.

A SHAREHOLDER inquired what was to be done with the balance that would be unissued of the capital of the re-constructed company of £387,000.

Another SHAREHOLDER asked a question with reference to the responsibilities that were taken over with the Falcon and Australasian Companies.

The CHAIRMAN: In reply to Mr. Marks, I can set his mind at ease entirely with respect to any fear he may have about our issuing shares below par—at a discount. Mr. Marks may feel perfectly sure that no board of directors—certainly not this Board—would undertake such a great personal liability in these days. There have been very important decisions, rendering it illegal to issue shares at a discount.

Mr. MARKS observed that his question applied not to the present Board, in whom he had perfect confidence, but to what might happen at a future period.

The CHAIRMAN: We will consider the point very carefully, and if our legal adviser says it is advisable that we should insert such a restriction in our Articles of Association we shall do so. As regards the Australasian Company, it would be taken over with a sworn statement of its liabilities and assets. Its assets exceed its liabilities. We shall only be liable for those reported to us and sworn to before we take over the Company. From that point of view there is no cause for anxiety. With reference to the total expenses of the litigation, I am not able to state the amount they will come to at present. It takes some time to tax these legal expenses very often, and for even legal gentlemen to send in their little accounts. As a matter of fact the total is not yet ascertained, but it will not be in excess of the provision made for it in our last balance-sheet. Mr. Marks also asked me to pledge my colleagues and myself not to embark in any future litigation, but that is a very difficult point to raise. People may tread on our toes. We do not mean to interfere with anybody, but if our valuable patents are infringed we must fight. There is a discretionary power we must exercise, otherwise you might proceed against us for letting our property lapse. We shall not, however, lightly enter into litigation, but we must jealously guard our property. Lawsuits, it may be remembered, vary very much. It is not every law suit that partakes of such gigantic proportions as that with the Edison and Swan Company. In reply to Mr. Lane-Fox, whom I am very glad to see here to-day, I never can be, I fear, quite in unison with him in the views he holds on these points. As to Mr. Lane-Fox establishing a lamp factory of his own, he is at perfect liberty to do that, taking his own risk. If I might venture, however, to give him a word of advice it would be to approach the Edison and Swan Company and see what could be got out of them. If he considers he has any grievance, and would lay it fairly before Mr. Forbes and Mr. Leyland, and the other gentlemen belonging to that Company, I have no hesitation in expressing my belief that they would be ready and willing to meet him in a proper and fair spirit. As regards the remark he made with reference to our purchase of the Falcon Works at a very high figure, I desire to point out that the figure is nothing like the par value at all, or nothing like the money spent on those works. As a matter of fact, those works are to be acquired at a very moderate figure indeed. To that I must add (and this is an important point) that we are paying for those works entirely in shares of this Company. That shows the amount of esteem in which our shares are held by persons outside the Company. If our shares were not considered a valuable property it is only fair to assume that the proprietors of the works would not have entered into this arrangement, but they see the advantage of it. As to the manufacture of locomotives, which they had rather carried on, that special branch will cease. We shall not manufacture locomotives unless we see our way to very remunerative contracts. What we propose to make at these works are engines of electrical machinery, for electricity cannot be generated without the engines, motors, and other things of large and heavy dimensions which we propose to make at these works. With reference to the question of unissued capital, that will remain available for issue at a future period. I hope that will be done at a premium. I only hope we may be called upon to issue that capital very shortly at a large premium. He then proposed resolutions giving the Directors power to enter into the proposed arrangement with the Australasian Company.

These were seconded and carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. NOEL, the following resolution was also carried unanimously:—

"*That it is desirable to reconstruct the Anglo-American Brush Electric Light Corporation (Limited), and that with a view thereto the Corporation be wound up voluntarily and that J. B. Braithwaite, jun., and E. Garcke, be, and they are hereby, appointed liquidators for the purposes of such winding up.*"

The CHAIRMAN next moved, and Mr. SELIGMANN seconded, the fourth resolution, as follows, which was carried unanimously:—

"*That the said liquidators be, and they are hereby, authorised to consent if required to the registration of a new company to be named 'The Brush Electrical Engineering Company (Limited),' with a Memorandum and Articles of Association which have already been prepared with the approval of the Directors of the Corporation, but which are to be subject to such alterations and modifications, if any, as may be found expedient.*"

On the motion of the CHAIRMAN, seconded by Mr. SELIGMANN, the fifth and last resolution, as follows, was put and carried unanimously:—

"*That the Draft Agreement submitted to this meeting and initialled by the Chairman for the transfer of the business and property of this Corporation to the new Company shall be, and the same is hereby, approved, and that pursuant to Section* 161 *of the Companies Act*, 1862, *the liquidators shall be, and they are hereby, authorised to enter into an agreement with such new Company (when incorporated) in the terms of the said draft and generally to carry the same into effect with such (if any) modifications as the liquidators may be expedient.*"

The CHAIRMAN: That concludes all the business of this meeting, and I can only say we will summon a further meeting to confirm these resolutions with the least possible delay.

On the motion of Mr. MARKS, seconded by Mr. SELIGMANN, a vote of thanks to the Chairman and Directors was unanimously agreed to.

The CHAIRMAN having briefly replied, the proceedings terminated.

The Australasian Electric Light, Power, and Storage Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held at the offices of the Company, 39, Coleman-street, E.C., on the 23rd inst., for the purpose of considering a proposed sale of the property and assets of the Company to the Anglo-American Brush Electric Light Corporation (Limited). Mr. B. H. Van Tromp presided.

The SECRETARY (Mr. J. H. Duncan) having read the notice calling the meeting,

The CHAIRMAN, said having regard to the very full and concise statement which has been sent to you through the post by a circular issued not only by this Company but by the Brush Company, in which the scheme for the amalgamation of this Company with the Brush Company is fully set forth and explained, I do not think it will be necessary for me to enlarge on it to any extent on this occasion. I may say that for the last two or three years it has been manifest to the shareholders that what we wanted to make this Company a success, and what we required to push our patents in Australia and the other colonies, was money. We were unable to go on with the undertaking in the manner which we desired in consequence of being crippled for want of capital. At our meeting held at Winchester House in 1887 I told the shareholders what our position was, and several of the shareholders on that occasion said that they were willing, so far as they were able, to find their proportion of any new capital that might be proposed to be raised. The same question arose in 1888 when we met in this house, and it was suggested that a committee of shareholders should be appointed to confer with the Board as to a scheme by which some fresh capital might be raised, because we knew that by the acquisition of the Edison patents we had very valuable inventions which could be made into a remunerative property if we had only the means of working them. We were, therefore, anxious to put some more money into the concern by way of raising new capital in the colonies and Australia in which we had an interest amounting to one-third, and by launching out in some new undertaking in India, Africa, or New Zealand, and see whether we could not produce a dividend-paying concern for you. We considered it was necessary to do this. If you remember, in January last, in pursuance of the suggestion that we made at the previous meeting, we prepared a scheme for the reconstruction of this Company and the raising of additional capital. The nature of that scheme was circulated among the shareholders, and I am obliged to confess to you that the result was not sufficiently satisfactory to justify our carrying it out. The consequence was that in the absence of money we were obliged to look around and find a partner having capital, and having the means of raising more if it was desirable. We did so, and eventually we came into communication with the Anglo-American Brush Company, which, as you know, had their meeting yesterday, which has been fully reported in the newspapers. They have passed a resolution in which they fully approve, in substance if not in detail, of the scheme laid before you. That being so, and having regard to the position we occupy, and the difficulty we have of raising more money while our shares are at a discount, as well as to the fact that our assets are not sufficient to justify our spending money on a very bold scale, we felt that it would be better to amalgamate with a Company having a large capital, and capable of infusing new blood into our undertaking. The Anglo-American Brush Company have the power to raise capital to the extent of three-quarters of a million. They have issued between £200,000 and £300,000, and they have also debentures to the amount of £75,000. The Chairman of the Anglo-American Brush Company said yesterday that, if within the next six months he did not pay a fair, if not a handsome dividend, that he would absolutely disappear from the scene. In that Company's prosperity we shall of course participate, for we are to hold £45,000 of their stock, and we shall share equally with them their profits. If they pay 10 per cent. on the capital which was originally theirs, on that proportion of it which they have given to us we shall also get 10 per cent. We shall have all the advantage of the capital that they will bring in to carry out the operations in Australia, and to work the Edison lamp out there and in India. I need not say that this subject has engaged the attention of the Directors for months past. We have worked day by day in this as in other matters for years, and I need hardly remark that it was a matter of great disappointment to us, after labouring hard as we did, and trying to do all that we could for the Company, that we saw, in the absence of money at our back, that it was absolutely useless to try and force a large business anywhere. That being the case we considered it was best to make this arrangement, and I trust you will concur in it. With regard to the agreement certain technical difficulties have arisen, but I do not think that they are in any way insurmountable, and I would ask you to be kind enough to pass the first resolution to authorise us to carry out the agreement as prepared and agreed

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to by us with such modifications as we may consider it desirable to make. I need not say that, if the modifications be of a very drastic character, that would be a matter on which it would be necessary to send out to you another circular in order to consult you. I ask you, therefore, to be kind enough to pass the resolution to-day, leaving it to the Directors to do the best they can to carry the matter through to your satisfaction. He concluded by moving the following resolution :—

"*It is hereby resolved to adopt, ratify, and confirm the agreement, dated the 12th day of July, 1889, and made between the Australasian Electric Light, Power, and Storage Company, of the one part, and the Anglo-American Brush Electric Light Corporation (Limited), of the other part; and the Directors are hereby authorised and requested to do all things that may be necessary for the purpose of giving effect to the said agreement, and carrying out the provisions thereof, either with or without modification.*"

Mr. F. ISAAC seconded the motion.

The SECRETARY, in reply to a Shareholder, said that the deferred shares were not entitled to anything under the original contract of amalgamation with the Edison Company until the other shares had reached par.

The CHAIRMAN, replying to Mr. Brown, said :—The Anglo-American Brush Company are going to reconstitute their Company and to take power to use electricity for the purposes of traction on tramways, &c., and that is why they had entered into an arrangement for the purchase of the Falcon Works, where, among other things, they are going to manufacture machinery to that end. I may say also that we are to hand over, if this arrangement is carried out, everything that we possess, not only the power patents, but all the patents that we have acquired. There are companies in England who are now making experiments with the view of using electricity for motive power on tramways. I myself, as chairman of a tramway company with a capital of £500,000, inspected a system at Canning Town, and, so far as I was able to judge, it was a perfect success, and I believe it is looked forward to with the greatest anxiety by shareholders of tramway companies. It is confidently anticipated that the shares will be at a premium. The fully-paid Anglo-American Company's £5 share is quoted at 4¼ to 4⅜. Our shares if we carry out this arrangement will rank equally with theirs.

Mr. BROWN : What is the value of your shares at the present time ?

The CHAIRMAN : The best test is what you can sell them for. Probably you will get 30s. for them if this arrangement is carried out. The Brush people talk of large dividends. They are looking forward to a much better condition of things. I need not say that the misfortune of this Company was that in the first years of our existence no less a sum than £87,000 of capital had absolutely disappeared out of £120,000, so that we were left with only about £30,000 to carry on our operations. We do not ask you to pass resolution No. 2 on the circular to-day. We think it would be an unwise thing to rush into liquidation until we are absolutely sure as to our position with regard to the other Company. We shall do nothing to materially change the condition of things without consulting you.

The resolution was then put to the meeting and unanimously adopted, and the Chairman having been thanked for presiding, the proceedings terminated.

The Falcon Engine and Car Works (Limited).

An extraordinary meeting of this Company was held at the offices, 41, Coleman-street, London, E.C., on Tuesday last. Mr. W. W. Duncan (Chairman of the Company) presided.

The CHAIRMAN, in the course of his remarks, said they had met for the purpose of getting the shareholders' consent to the sale of the Company, with all its assets and liabilities, to the Brush Electrical Engineering Company, which is a new company to be formed to embrace the Anglo-American Brush Electric Light Corporation, the Falcon Company, and the Australasian Electric Light Company. The Directors had for some considerable time been carefully and anxiously considering in what manner they could most usefully and advantageously extend the scope of the works and business of this undertaking. This policy had been dictated and, indeed, forced upon us by the fact that we found it impossible to keep our engineering department fully employed. Steam locomotives on tramways, especially in this country, have been lately to some extent in disfavour, and there has consequently been no extension of the system, and therefore an appreciably diminishing number of orders for tramway engines. Our car department has been kept fairly well in full work, but here again we have to meet with pretty severe competition, and all the large tramway companies now make their own cars. The necessity was therefore forced upon us to endeavour to embrace other work for which our factories were suitable, and we have for the last eighteen months been diligently looking into various matters and businesses that have come under our observation, with this object in view. In this manner we got into negotiation with the Brush Company, who were anxious to secure larger works, as their business was rapidly extending, and, moreover, they entertain the question of bringing the Company into prominence in connection with electrical motive-power on tramways, which there is no doubt is now imminent. The negotiations have been proceeding for some time, and have resulted in the scheme which is now before you, and which we have the greatest confidence in recommending you to adopt. In our negotiations with the Brush Company the Directors had done the best they could for the shareholders, and it was now for them to decide whether they would take it or leave it. The Brush Company has thoroughly established itself in the front rank of companies connected with electricity in all its branches, and I am firmly of opinion that those companies which have managed to live through and contend against the difficulties that have presented themselves in this enterprise are now about to reap a rich harvest. It may be argued by some of you that we are about to hand you over to a non-dividend-paying company. This is true in fact; but the only reason why the Brush Company did not pay a dividend last year was in consequence of a legal action which was hanging over it, and which has since been settled. In consequence of the absorption of the Australasian Company, it will be able to extend its business in Australia, New Zealand, South Africa and India, where there is undoubtedly a most promising and lucrative field for electrical lighting and electricity generally. He thought they would agree that the Directors, in proposing this bargain, had disregarded all thought of what were their individual interests, as of course if you adopt the scheme they lose their position as Directors without any compensation; but they desired not credit for this, as they had only done what they considered they were bound to do as the trustees for the shareholders. The whole business was to be transferred to the Brush Company, including, of course, all accrued profits of the Falcon Company, and it was not, therefore, in the power of the Directors to declare any dividend.

Mr. SUTTON expressed his disappointment that there was not to be a dividend upon the Preference Shares, and, as one of the auditors, had made it his business to call upon the secretary to ask for some explanations, as neither of these companies were paying dividends. He did not consider that the prospects of the Brush Company were very bright, but believed that electricity would come to the front, and had, indeed, always believed in it. This being so, he would not oppose the scheme, but would throw upon the Directors the responsibility of recommending the course, as he had every confidence that they would not present the scheme if they did not believe it to be in the shareholders' interest.

The Rev. W. J. STOBART stated that he was a shareholder in the Brush Company, and although he had only received one dividend from that company, he was of opinion that their business was improving from year to year. He would like to see some addition to the Board of the Brush Company, and was of opinion that it would be an advantageous thing for both companies if the amalgamation was carried through. He was also of opinion that there was an infinitely better prospect for shareholders in the future of electricity than in the future of steam locomotion or tramway extension, as people connected with tramways found that tramways in small provincial towns did not pay, while the large cities were now fully supplied. He formally proposed the resolutions.

The resolutions were seconded by Mr. SANDERSON and carried.

The CHAIRMAN remarked that it was intended to nominate Mr. Sanderson to represent the shareholders on the Board of the new Company.

Mr. SANDERSON expressed his willingness to act, and after a few further remarks as to the distribution of the new shares, the meeting closed with a vote of thanks to the Directors and officers of the Company.

Exeter Electric Light Company.

The first annual general meeting of this Company was held on Tuesday at the Athenæum, Bedford-circus, Exeter. The chair was occupied by Mr. W. H. Ellis (Chairman of Directors), and there were also present Messrs. L. J. Kennaway, H. C. Massingham (Managing Directors), C. J. D. Sanders, E. E. Braud, R. P. Bishop, J. Knill (Auditor), and H. W. Michelmore (Secretary).

The CHAIRMAN, in moving the adoption of the report, which appeared in our last issue, said they must all feel exceedingly glad after the difficulties they had gone through to find that the Company had been so well and successfully established. Their prospects were of the very best; they had already had many arc lights applied for, and at least 1,000 incandescent lamps for internal use. This, however, was nothing as compared with what they expected to get; in fact, since the report was published they had had a great number of orders for lamps besides those referred to in the report. It was only a question of capital. He believed they had got as many orders for lamps as they could execute, and it was desirable that shareholders should assist in obtaining more capital, and in inducing their friends and the public to join the Company. It was the intention of the Directors to issue a fresh circular, asking people to join, so that with more capital they might have the means of extending the supply of light. He would confidently appeal to the public to do so, even their friends in the gas company, for the latter might with advantage take shares in the Electric Light Company. He did not think for a moment that the electric light was going to injure the dividends of the gas company. He believed there was such a field for the use of gas, as well as electricity, that the more the electric light was used the more would be the demand for gas. As years went on the cry would be for "more light," and, instead of being losers, gas companies, as well as themselves, would be gainers. He trusted that the shareholders and the public would respond in such a manner as to enable the Company to supply the large field before them.

Mr. MASSINGHAM seconded. He endorsed the remarks of the Chairman on the question of the electric light in relation to health. The electric light was certainly worth considerably more than either candle, oil, or gas, and the price at which they proposed to supply it would, he thought, compare very favourably with that of other illuminants. He also agreed with the Chairman that there was plenty of room for both the electric light and gas companies, in proof of which he instanced Taunton, where the electric light was introduced four years ago, and where, instead of injuring the gas company, it had created a demand for better gas lighting, and more of it. The result was that since the introduction of the electric light the gas company had sold more gas than at any previous period during their existence, and at the present time one of the shareholders of the gas company there was a director of the electric light company. With regard to the price, with the exceptions of Taunton and Bath, the electric light would be supplied in Exeter at a lower price than in any other city in the kingdom; and, so far as his knowledge went, lower than on the Continent or America. In London the prices averaged, he believed

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about 100 per cent. more than the price they (the Exeter Company) charged, whilst, taking the provinces, Eastbourne, Brighton and Hastings averaged 200 per cent. more than they were charging at Exeter. They had started in Exeter on a totally different footing to the speculative companies which had been established in some places. It was started with a comparatively small capital, which they hoped gradually to increase as the business extended. He thought they had a very bright future before them.

The report was unanimously adopted.

The SECRETARY pointed out that while the Company would prove a benefit to the city on the score of health, it would also be a financial success and pay substantial dividends.

Mr. MASSINGHAM added that in the case of the Taunton Company a share had never passed hands at less than par; and at the present time they were rapidly changing hands at 5 per cent. premium.

On the motion of Mr. KNILL, seconded by Mr. BISHOP, a vote of thanks was accorded the Chairman and Directors, and a similar compliment having been paid to Mr. Massingham and the Secretary, the meeting terminated.

Hong Kong Electric Company.

The statutory general meeting of this Company was held at the City Hall, Hong Kong, on the 25th May, the Hon. B. Layton (Chairman) in the Chair.

After the Secretary had read the notice convening the meeting,

The CHAIRMAN said: This is merely a formal meeting called in accordance with the ordinance, and there is nothing but formal business to be put through. The capital has all been subscribed and we are going on with the contracts for the machinery. The orders are all closed and we expect the machinery to be here towards the end of the year. We have to elect two auditors, and the Directors suggest that Messrs. Stewart and Coxon be elected. We have also to elect a Director, and Mr. Davies' name has been suggested.

Mr. R. K. LEIGH proposed the election of Messrs. Stewart and Coxon as auditors.

Mr. S. L. DARBY seconded, and the motion was adopted.

The CHAIRMAN proposed the election of Mr. T. E. Davies as a Director.

Mr. LEIGH seconded, and the motion was adopted.

The CHAIRMAN: That is all the business, unless any gentleman has any questions to ask.

There being no questions, the CHAIRMAN thanked those present for their attendance, and the meeting terminated.

Anglo-American Telegraph Company (Limited).

The following is the report of the Directors of this Company to be presented to the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House, 50, Old Broad-street, E.C., on Tuesday, the 30th inst.:—

1. The total receipts from the 1st January to 30th June, 1889, including the estimated balance of £1,325. 13s. brought forward from the last account, are estimated at £144,992. 7s. 6d. This amount, however, is subject to revision, dependent upon the result of the law suit still pending between this company and the Paris and New York Telegraph Company. The traffic receipts show an increase, as compared with the corresponding period of last year, of £68,264, consequent upon the increase of tariff from 6d. to 1s. per word, which came into force on the 1st September, 1888.

2. The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £46,277. 6s. 6d.

3. One quarterly interim dividend of 12s. 6d. per cent. on the Ordinary Stock, and of 25s. per cent. on the Preferred Stock, was paid on the 1st May, 1889, absorbing £43,750, and a second quarterly dividend of 15s. per cent. on the Ordinary Stock and £1. 10s. per cent. on the Preferred Stock, will be paid on the 1st August, 1889, absorbing £52,500, leaving a balance of £2,465. 1s. to be carried forward to the next account.

4. The Company's repairing ss. "Minia" has been engaged during the past half-year in the repair of the Tricore Cable, and the North and South Placentia Cables, between Newfoundland and Nova Scotia; she had also repaired the Salcombe-Brest Cable, on behalf of the Submarine Telegraph Company, and after undergoing certain necessary repairs in London, and taking in cable for the partial renewal and diversion of the St. Pierre-Duxbury section, completed that work on the 12th inst.

5. With the exception of the Brest-St. Pierre Cable, which was broken on the 17th inst. in deep water, the Company's cables and land lines are in good working order.

6. The Paris Conseil de Prefecture in March last heard and gave judgment upon the technical legal points referred to them by the Court of Appeal in the action brought by this Company against the Paris and New York Telegraph Company.

The decision of the Conseil is in effect that the joint-purse agreements of 1880 and 1882 were beyond the authority given to the French Company by its concession, and that the letter of the Minister of Posts and Telegraphs of 30th December, 1886, was in the nature of an official summons to that Company to break such agreements.

The Directors, after consultation with their legal advisers in Paris and London, decided to appeal to the Conseil d'Etat against this judgment, and the necessary steps are being taken for the purpose.

7. The increase of tariff from sixpence to one shilling per word, which came into operation on the 1st September last, has approximately doubled the receipts without increasing the working expenses.

This result, so far, may be considered as fairly satisfactory, and leads the Directors to hope, that with freedom from interruption to the cables and increased business, still further improvement may be reasonably anticipated.

8. The Directors regret to announce the resignation, through failing health, of their colleague, Mr. William Barber, who has for many years occupied a seat at the Board. Mr. Samuel Barber, his son, has been appointed to fill the vacancy thus occasioned, during the remainder of the term for which his father was elected.

The Globe Telegraph and Trust Company (Limited).

The following is the report of the Directors to be presented to the sixteenth ordinary general meeting to be held at Winchester House, 50, Old Broad-street, London, E.C., on Tuesday the 30th inst., at one o'clock:—

The net revenue of the Company for the year ended the 18th July, 1889, after deduction of expenses, amounts to £188,624. 1s. 2d. which, with the balance of £2,107. 1s. 3d. brought forward, make a total of £190,731. 2s. 5d. From this amount there has been distributed the sum of £126,300. 15s. 2d. in interim dividends, leaving an available balance of £64,430. 7s. 3d.

The Directors recommend the payment of a final dividend for the year of 3s. per share on the Preference Shares, and of 4s. per share on the Ordinary Shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income tax, upon the Preference and 4⅝ per cent. net upon the Ordinary Shares (against 3½ per cent. for the preceding year), and carrying forward a balance of £2,053. 16s. 5d.

As indicated in the last report, the Imperial German Government have acquired the lines of the German Union Telegraph Company of Berlin, and that company and also the German Union Telegraph and Trust Company (Limited) have been liquidated. This Company has received its proportion of the return of capital. In addition 400 shares of the French Telegraph Company, Paris to New York, have been sold; and 66 shares of the German Norwegian Cable Company have been drawn for amortisation, and paid off at par, less exchange.

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The following re-investments have been made, viz.:—7,444 Eastern Telegraph Company's new Shares; £62,000 Direct Spanish Telegraph Six per Cent. Debentures; 2,700 West Coast of America Telegraph Shares (fully paid); 2,750 American Telegraph Cable Company's ($100 fully paid) Shares. Five per Cent. Guarantee of the Western Union Company of New York; 3,145 West African Telegraph Company's Shares, £10 fully paid. The income from the re-investments will, it is anticipated, show an improvement on the securities paid off.

In conformity with the Articles of Association, Sir John Pender, K.C.M.G., and Sir James Anderson, two of the Directors, retire, but, being eligible, offer themselves for re election.

The auditors, Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths and Co.), and Mr. William Griffith, B.A., Barrister-at-Law, also retire at the meeting, and offer themselves for re-election.

The Telephone Company of Austria (Limited).

Report of the Directors to be presented at the sixth ordinary general meeting of the Company, to be held at the offices of the Company, 53, New Broad-street, on Wednesday, the 31st inst., at 3 p.m.:—

There has been expended on capital account a further sum of £8,546. 5s. 10d. The gross receipts from all sources were £13,969. 6s. 5d.; after providing for all expenses, including £3,604. 10s. 6d. for debenture interest and preference dividend, and £2,206. 0s. 10d. for royalties and taxes to the Austrian Government, there remains a net profit of £2,352. 10s. 5d., which, with the amount, £931. 14s. 1d., brought forward from last year, leaves a balance to the credit of profit and loss account for the current year of £3,284. 4s. 6d.; this amount it is proposed to carry forward.

The Directors are much pleased to again report a continued increase in the number of subscribers to the Company's Exchanges, as shown by the following table:—

	No. of Subscribers.	Inc. over previous 12 mths.	Rental.	Inc. over previous 12 mths.
			Fl.	Fl.
31st March, 1888	2,036	..... 245	161,801	 21,618
31st March, 1889	*2,299	..... 263	182,550	 20,749

*Exclusive of 142 "Extension" Telephones, which were erected during the year, giving an additional annual rental of 4,510fl.

Installations in the towns are still progressing at the usual rate, and so far as the Board can judge seem likely to continue to do so. The calls of subscribers now average over 64,000 per week, as against 60,000 last year.

The Austrian Government having decided to run a trunk line from Vienna to Prag, your Directors are now erecting, at a very heavy cost, a new and improved switchboard at their Prag Exchange, to correspond with the system in use in Vienna. This expense was undertaken in the first instance with the view of assisting the Austrian Government in their endeavour to carry out successfully their scheme of inter-urban telephony, but will also become a productive outlay as increased and improved switchboard accommodation will, in a time not far distant, become necessary, owing to the constantly-growing number of subscribers in that city.

The question of the prolongation of the Company's concessions is now under the consideration of the Government, a very carefully considered petition having been laid before the Minister of Commerce, and it is expected that the matter will be decided this autumn.

The transmission and delivery of telegrams by the Company's Exchanges has very considerably increased during the past year, the number of messages dealt with averaging 2,150 per week, and although this service has not yet proved remunerative to the Company, its advantages indirectly are very great, and sufficient to justify its continuance.

The cordial and satisfactory relations of the Imperial Royal Government Telegraph and Postal Authorities and Municipal bodies with the Company remain unaltered.

It is with regret that the Directors have to announce the retirement from the Local Board in Austria of Mr. Joseph Wessely, owing to ill health. The thanks of the shareholders are again due to him, and very specially to Dr. Eugen Weissel, for their continued services during the past year, as also to Mr. R. Howard Krause for the highly satisfactory manner in which he continues to perform his duties as general manager.

Mr. C. L. W. Fitz-Gerald retires by rotation from the Board, but being eligible, offers himself for re-election.

Your Directors, to meet the wishes of the Consolidated Telephone Construction and Maintenance Company (Limited), have invited Mr. Joseph Hicks Buckingham to a seat on the Board, and will propose his election accordingly.

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., also retire, but being eligible, offer themselves for re-election.

NEW COMPANIES REGISTERED.

WOODHOUSE AND RAWSON UNITED (LIMITED).—Registered by Johnson, Budd and Johnson, 24, Austinfriars, E.C., with a capital of £350,000 in 30,000 Preference and 40,000 Ordinary Shares of £5 each. Object—to acquire, take over and amalgamate the following businesses, and to develope the same:—(*a*) Woodhouse and Rawson (Limited), (*b*) Woodhouse and Rawson Electric Supply Company of Great Britain (Limited), (*c*) Woodhouse and Rawson Electric Manufacturing Company (Limited), (*d*) Woodhouse and Rawson Electric Contract and Maintenance Company (Limited), (*e*) C. L. Baker and Co. (Limited); any rights, trade marks, licenses, inventions, plant, stock-in-trade, and the freehold premises known as the West Kensington Hall Estate, including the factories and buildings thereon; to carry on the business of an electrical supply and manufacturing company. The first subscribers are:—Lord Aberdare, P.C., Duffryn; P. Rendson, Woodhurst, Crawley; Sir T. Farrer, Bart., Abinger, Dorking; Lieut-General Sir J. Stokes, K.C.B., Good Rest, Hayward's-heath; Sir J. Coode, K.C.M.G., 35, Norfolk-square, W.; A. J. L. Capport, K.C.I.E., 11, St. George's-terrace, S.W.; C. C. H. Vincent, C.B., 1, Grosvenor-square; F. L. Rawson, 68, Cornwall-gardens, S.W. There shall not be less than three nor more than nine directors. The first to be appointed by the subscribers to the Memorandum of Association. Qualification, 50 shares. Remuneration to be determined in general meeting.

RUSTON, PROCTOR AND CO. (LIMITED).—Registered 12th inst. by Grundy, Kershaw and Co., 19, Southampton-buildings, W.C. Capital £250,000 in £10 shares. This company is established to take over the business of engineers carried on by Joseph Ruston, at Lincoln and elsewhere, trading as Ruston, Proctor and Co. The new company takes power to construct electric, water, or gas works, to generate, store, and use electricity for any purpose, and to carry on the business of an electric lighting or storage company, or electrical engineers. Signatories (with 1 share each): Joseph Ruston, J. T. Tweed, Lincoln; G. M. Hutton, Gainsboro'; A. E. Tylor, 117, Leadenhall-street, E.C.; S. Mosley, R. F. Allured, 104, King-street, Manchester; Theodore Fry, M.P., Darlington. Messrs. Ruston, Hutton, Tylor and Fry are the first directors; qualification, £1,000 in shares or stock; the company in general meeting will determine remuneration.

CITY NOTES, &c.

BELL'S ASBESTOS COMPANY.—The directors of this company have declared an interim dividend of 12s. 6d. per share, free of income-tax, for the half-year ending June 30 last, being at the rate of 25 per cent. per annum.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended July 19, 1889, amounted to £4,167.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—At a meeting of the directors of this company, held on Wednesday, the audited accounts for the half-year to June 30 were submitted, and it was resolved, after providing for the dividend on the preference shares and placing £6,000 to the reserve fund, to recommend the payment of a dividend on the ordinary shares at the rate of 9 per cent. per annum, free of income-tax, leaving £345. 4s. 9d. to be carried forward.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 19, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,680.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

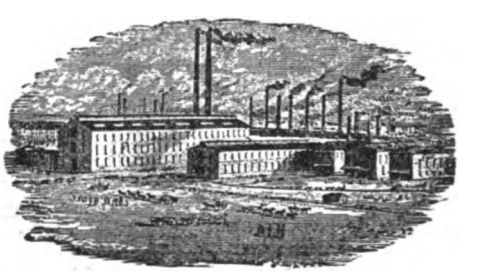
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, July 24, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 24, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	2½%	Anglo-American	53 54	3 14 1	Jan., Apr., July, Oct.	53½	53
2,614,820	Stock	5%	Do. Preferred	90½ 91½	4 7 5	,, ,,	91½	90¾
2,614,820	Stock	...	Do. Deferred	18¼ 18¾	...	February	18⅝	18⅛
130,000	£10	10%	Brazilian Submarine	13 13½	5 3 8	Mar., June, Oct., Dec.	13⅜	13 5/16
112,900	£100	5%	Do. 5 per Cent. Bonds	102 104	4 16 2	January and July	103	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	..	...
16,000	10	9%	Cuba Submarine	14⅜ 15¼	5 18 0	February and August	15¼	...
6,000	10	10%	Do. Preference 10%	19½ 20½	4 17 7	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3½ 4	...	March & September	...	...
6,000	5	10%	Do. Preference 10%	8½ 9½	5 5 3	April and October	...	...
60,710	20	3½%	Direct United States	10⅜ 10⅝	5 1 5	Jan., Apr., July, Oct.	10 11/16	...
380,000	10	5%	Eastern	13⅜ 13⅝	4 15 7	,, ,,	13⅝	13⅜
70,000	10	6%	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	15½	15 3/16
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109¼	109
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 111	4 10 1	February & August	109	108¾
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct	13⅝	13⅜
3.0,000	100	6%	Do. 6 per Cent. Debentures, 1891	104 106	5 13 2	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	6%	Globe Telegraph and Trust	8⅜ 8⅝	4 15 9	Jan., Apr., July, Oct.	8 1/16	8⅜
178,992	10	6%	Do. 6 per Cent. Preference	14⅞ 15⅛	3 19 4	,, ,,	15⅛	15
150,000	10	7½% for '88	Great Northern	15⅛ 15⅜	4 12 4	Jan., July, and April	15 1/16	14⅞
17,000	25	15%	Indo-European	39 41	6 1 11	April and October	...	...
9,000	8	5%	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	3/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
30,000	10	6% for '88	West Coast of America	10 10½	...	January and July	10⅜	10¼
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅜ 2⅝	...	...	2 1/16	2 1/16
34,563	10	12/0*	Do. 1st Preference 6%	11⅞ 12⅛	...	April and October	12⅛	12
4,669	10	†	Do. 6 per Cent. 2nd Preference	14 15	...	...	14⅛	14 1/16
45,181	15	6%	Western Brazilian	11 11½	6 10 4	March & September	11⅜	11 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	7%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	4 8 3	...	...	...
80,000	5	25%	United	15 15⅛	5 12 11	June and December	15 5/16	15⅛
55,000	5	3/0	United River Plate	5¾ 6¼	...	January and July	6⅛	6
			ELECTRIC LIGHT.					
23,003	5	..	Anglo-American Brush (£4 paid)	3¼ 3⅜	...	...	3½	3⅜
23,692	5	...	Do. (fully paid)	4¼ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	4¼ 4½	...	...	4⅞	4¼
			MISCELLANEOUS.					
37,350	12	30/0	Telegraph Construction and Maintenance	42 44	5 6 3	March and July	44	42¾
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19½	19⅛

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIDUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED OURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 585.—Vol. XXIII. FRIDAY, AUGUST 2, 1889. Price Fourpence.

NOTES.

We sincerely trust that the rumours which have reached us as to the refusal of the Treasury to sanction the grant for the Standardising Laboratory are not authentic, but if what we hear be true the scheme is at present as far from realisation as ever. After the careful and explicit manner in which the necessity for the step was recently placed before Sir Michael Hicks-Beach it is not a little surprising that the purport of the scheme should continue to be so completely misunderstood. The Government seems to be labouring under the impression, first, that the scantiest accommodation and the most meagre equipment will be amply sufficient to despatch the trivial amount of business which they anticipate; and, secondly, they evidently imagine (with even greater fatuity) that the ultimate object of the movement is to gratify the tastes of a few scientific faddists akin to the species of Endowed Researchers. Nothing could possibly be further from the truth. The fact is simply that the legislation of 1882 and 1888, as well as the various Acts confirming the Provisional Orders granted by the Board of Trade, cannot possibly be carried into effect in the absence of some provision for certifying the accuracy of electrical apparatus. It is expressly stipulated in these Acts that every consumer shall be supplied with a meter, that every such meter shall be a "certified meter," and that if it is not so certified the company cannot legally recover moneys from the consumer. If the Government, therefore, declines to make adequate provision for certifiying meters, the public will soon discover that there is a serious hitch in the administration of the Electric Lighting Acts. As to what may constitute an adequate provision we shall know better at this time next year; but we have perfectly good grounds for stating our opinion that permanent arrangements for testing say 100 meters *per diem* would not long remain a superfluous provision. Finally, it should by no means be overlooked that, what with the fees to be paid for the tests, not forgetting the ammeters and voltmeters, which are almost as important as the meters themselves, the institution once set going will almost certainly become self-supporting, even if it does not speedily yield a surplus revenue.

A letter has been addressed to the Board of Trade by the London Chamber of Commerce suggesting the desirability of certain modifications in their regulations with respect to overhead wires. These regulations have received the careful attention of a Sub-Committee of the Electrical Section, and we are glad to hear that owing to the fact that the suggested alterations are few and unimportant, and are likely to be accepted by the Board of Trade, there was no necessity to trouble the President with a deputation or to call a general meeting of the Section.

We publish in another column the report of the Streets Committee of the Commissioners of Sewers on the lighting of the City. It will be seen that the Committee propose to accept the tenders of the London Electric Supply Company, the Metropolitan Electric Supply Company, and the Anglo-American Brush Corporation. The specification, which was published in our issue of February 8th, 1889, did not specify either the number or the candle-power of the lamps to be erected; but it appears from the report that 1,730 gas lamps will be displaced by 395 arcs, at a cost of £10,024 per annum, as compared with an existing expenditure of £5,530. The tender of the London Electric Supply Company amounts to £24. 3s. 10d. per arc lamp per annum (every alternate lamp being extinguished at midnight), whilst the Metropolitan and the Brush Companies each tender at the rate of £26 per lamp per annum to burn all night. It will be remembered that the concession conveys the right to supply electricity to private consumers within the same area, and that it is also provided that as soon as the profits exceed 10 per cent. upon the invested capital the surplus is to be "divided equally between the contractor and the consumer." The meeting adjourned without coming to any decision.

A seven per cent. dividend is at any time a very welcome windfall, and it is not surprising, therefore, that the meeting of the Edison-Swan Company, on Tuesday last, was of the mutually congratulatory description, especially as the dividend was accompanied by the announcement of the cessation of costly litigation and the cheering prospect of further dividends to come. The only person who is apparently left out in the cold is Mr. Edison, whose "B" shares, amounting to about one-fourth of the total capital of the company, stand in the position of Deferred shares, and are not entitled to any dividend until the "A" shares have received the full amount of seven per cent. cumulative dividend from the commencement of the company. The very modest royalty of one farthing per lamp which is to be given to the Brush Company under their Lane-Fox patents, is not likely to prove the source of a very handsome income to the recipients, unless indeed the lamp trade assumes herculean dimensions in the immediate future. This

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contingency is, however, guarded against by the further stipulation that the royalties are never in any one year to exceed the sum of £375, that is to say, every lamp after the 360,000th is to be free even from the microscopic tax of the smallest coin of the realm. The cave-in of the Brush is therefore somewhat more complete than we had anticipated.

In place of the abandoned Technical Education Bill, the Government have lost no time in introducing a fresh one, which is entitled the Technical Instruction Act. The difference in title does not at first sight convey much meaning, but a glance at the new measure reveals the significance of the change; for whereas the Technical Education Bill introduced technical instruction into schools to form part of the ordinary course of education, the present Bill is designed to create technical schools where technical instruction may be had by those who care to receive it. If this Bill passes in the present Session, as we hope it may, there will not be much cause to lament the loss of the other. It is true we lose the widespread technical education which the Board Schools would have been empowered to give under the abortive Bill; but as that measure took no account of Voluntary Schools where technical education was as much needed and as loudly demanded as anywhere else, its limited application would have been used chiefly to give an unfair advantage to rate-supported schools.

As the friends of the Board Schools refused to let the Voluntary Schools have any aid out of the rates for technical educational purposes, the Government have transferred the powers to County and Borough Councils or Sanitary Boards, who may supply or aid out of the rates technical and manual instruction, but not at any elementary school to scholars receiving instruction in the obligatory or standard subjects prescribed by the Education Department. That is to say, the scholars of Board and Voluntary Schools may obtain technical instruction on neutral ground, where it may be hoped sectarian jealousies will not creep in. The rate in aid must not exceed one penny in the pound. Technical instruction is defined to mean instruction in the principles of science and art applicable to industries, or of science and art to specific industries or employments. Manual instruction is defined as meaning instruction in the use of tools, and modelling in clay, wood, or other material.

In our correspondence columns will be found an interesting letter from Mr. J. D. F. Andrews on the use of condensers in the distribution of continuous currents. Our correspondent's experiments have led to the conclusion which we expressed last week—that the method possesses little practical advantage. Mr. Andrews is, however, of opinion that in connection with alternating currents "the applications of condensers are likely to be very valuable and varied," and he instances their employment as a substitute for safety-fuses.

"Telegraphic Facts and Figures" formed the subject of a leading article in one of the Glasgow papers a few days ago. Chief among the facts on which the leader was based was the statement that 3,400 candidates had recently presented themselves for examination when there were only 15 vacancies! In reality the number of candidates who presented themselves on the occasion referred to, namely, for 16 London vacancies, was 457. On the same date 129 candidates were examined in Dublin for 6 vacancies; and in Edinburgh for 10 vacancies 122 persons were examined. Thus there were only 708 candidates for 32 vacancies instead of 3,400 for 15.

Ironmongerdom has, we believe, great hopes of partaking in the profits of the present electric lighting revival, though beyond an increase in the demand for electroliers and glass shades, we fail to see how the present "boom" will benefit the ironmonger. A clause in all the Provisional Orders now gives the supply companies power to refuse to connect unless the house-wiring has been done to their satisfaction, and the day is gone by when any bell-hanger or tinker was considered capable of properly wiring a building. We venture to think, therefore, that the "wiring" orders received by ironmongers are not likely to overwhelm them, nor do we see that the retail demand for switches and cut-outs is likely to become so extensive as to make even the most enterprising ironmongers "rich beyond the dreams of avarice."

The current issue of the *Journal* of the Institute of Electrical Engineers is one of the most interesting and valuable numbers that we have had the pleasure of receiving for a long time past. On a portion of its contents we offer some critical observations in our leading columns this week. We are sorry, however, to notice that the peculiarities of editing which have been commented upon before still continue to be as conspicuous in the *Journal* as ever. Scissors and paste are the legitimate appliances of all editors; but there is one other editorial weapon, though less talked about, equally legitimate and even more necessary to every discriminating editor, namely, the knife; and this is an instrument which appears to be wholly unknown to the Editing Committee of the Electrical Engineers' *Journal*. How, otherwise, would such irrelevant trivialities as the following be left in the reports of their learned proceedings?:—

"Mr. A.: Could you come to this corner, Mr. ———?

Prof. B.: It is difficult to do so; there is something in the way, and it is much better to be close here," &c.

The Electrical Exhibition at Bingley Hall was formally opened yesterday by Lady Randolph Churchill. A brief congratulatory speech was delivered by Lord Randolph Churchill, and Mr. Ansell, Chairman of the Executive Committee, gave a retrospect of the steps which led to the formation of the present Exhibition. The great local interest which is taken in the Exhibition was shown by the large and representative attendance at the opening ceremony.

Weybridge.—The Woking Electric Supply Company have given notice of their intention to apply for a Provisional Order for this parish.

Woking.—The Woking Electric Supply Company have given notice of their intention to apply for a Provisional Order for the parish of Woking.

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Atherton.—The Lancashire and Cheshire Electricity Company have given notice to the Local Board of their intention to apply for a Provisional Order for the district.

Epping.—At the last meeting of the Epping Rural Sanitary Authority a notice was read stating that the Municipal Electric Light Company intended to apply for a Provisional Order.

Telegraphic Communication with Constantinople.—On and after the 1st of August direct telegraphic communication will be established between Vienna and Constantinople *viâ* Belgrade and Salonica.

Tchernigoff (Russia).—The Town Board of Tchernigoff has decided to adopt the electric light, and are in search of contractors for the work. Inquiries should be made of Mr. Freedman, mayor of Tchernigoff.

Bromsgrove.—The Bromsgrove Local Board has been served with notice from the Midland House-to-House Electric Lighting Company of their intention to apply for a Provisional Order to supply electricity in the district.

Postal Telegraph Promotions – Mr. Kerry, Telegraph Superintendent at Bristol, has been appointed to the Postmastership of Warrington; and Mr. West, Telegraph Superintendent at Hull, to the Postmastership of Banbury.

Bacup.—At the last meeting of the Town Council letters were read from two electric lighting companies, giving notice of intention to apply to Parliament for powers to supply electricity for lighting purposes in the borough of Bacup.

Portsmouth.—The Town Council have entered into a contract for the lighting by electricity of the esplanade from the Clarence Pier to the New Pier at East Southsea—a length of a mile and a-half on the sea front—from the 1st of August until the 8th.

Todmorden.—At the meeting of the Todmorden Local Board, on Wednesday last week, a letter was read from an electric lighting company stating that they were about to apply to the Board of Trade for electric lighting powers. The letter was referred to the Highway Committee.

Gorton.—The General Purposes Committee of the Gorton Local Board have received communications from two local electric lighting companies, giving notice of their intention to apply for a Provisional Order to supply the district with the electric light for public and private purposes.

The Electric Meter Competition.—The Committee charged with making the awards in the Electric Meter competition organised by the Municipality of Paris have commenced work, and their report may be expected within a few months' time. The only well-known competitors are Mr. Ferranti and M. Serrin.

Edison-Swan Annual Excursion.—The Edison-Swan Company's workpeople held their annual excursion on Saturday, 20th July, at Yarmouth. A very pleasant day was spent, the weather being exceptionally fine. Dinner was served to a large company in the Aquarium, after which several toasts were given and heartily drunk.

Penryn.—At the last meeting of the Town Council a letter was read from the Falmouth Gas Company stating that it was the intention of the company to make application for the necessary license to supply electricity within the area of the borough of Penryn, and asking the Council to give the matter their favourable consideration.

Electric Lighting Tenders.—The Municipality of Port Louis (Mauritius) invite tenders for lighting that town by gas or electricity. The Vestry of St. Mary Abbott's, Kensington, are also advertising for tenders for the electric lighting of a portion of the Kensington Town Hall. Further details will be found in our advertisement columns.

Penzance.—At the last meeting of the Town Council the Lighting Committee reported that a notice had been received from the Devon and Cornwall Electric Light Supply Company of their intention to apply for a Provisional Order. A similar notice had also been received from the Electric Construction and Maintenance Company.

The Edinburgh Exhibition.—On behalf of the Executive Committee formal application has been made to the Edinburgh Merchant Company for the use of ground belonging to them at Meggatland as the site of the forthcoming Electrical Exhibition. The Master has called a special meeting of the Governors to dispose of the matter.

Cowpen.—On Saturday night last Messrs. Nicholson and Jennings made a public experiment with five lights at Waterloo and Cowpen Quay, and the test proved exceptionally satisfactory. Messrs. Nicholson and Jennings commence their agreement on the 15th of August to light the township of Cowpen with 18 lamps for a term of five years at £525 per annum.

Exeter.—The Exeter Electric Lighting Company has commenced the erection of supports to carry the wires through the streets. At a recent meeting of the Town Council it was resolved that the company should be informed that the permission to erect posts in the public streets was subject to the right of the Council to withdraw it, and to require the removal of the posts at any time, on twelve months' previous notice being given, irrespective of any question other than the will of the Council.

Fairbairn's Sight-Feed Lubricator.—Woodhouse and Rawson United are now manufacturing a new form of lubricator (Fairbairn's Patent), which possesses the great advantage of being perfectly independent and applicable to any bearing. The amount of oil in the lubricator can be seen at a glance by the position of the piston-rod above the cup. The same firm have also brought out an oil filter, called the "Diamond," which should effect a considerable economy in the oil bill, and the first cost of which is very moderate.

Electrical Distribution.—The United Electrical Engineering Company have just issued a popularly written well-illustrated pamphlet, entitled "Electrical Distribution." The manifold advantages of electricity for light and power purposes are clearly and concisely set forth, and figures are given to correct erroneous impressions as to the clearness of the electric light and the unremunerative character of central station enterprise. The pamphlet forms an eminently readable and instructive little publication.

Society of Engineers.—On Tuesday last the Society of Engineers visited the Outfall Sewage Precipitation Works, now in progress at Crossness. The party proceeded from Westminster by a special steamboat, and were entertained at luncheon by the contractor, Mr. Wm. Webster. After luncheon the party were conducted over the works by Mr. F. E. Houghton (resident engineer) and Mr. Webster. The visitors were also shown Mr. Webster's electrical method of purifying sewage (see *The Electrician*, March 29, 1889, p. 588), which has now been in operation for over 12 months.

Clerkenwell Vestry.—The Vestry Clerk of St. Martin's-in-the-Fields has written asking Clerkenwell to endorse the following resolution passed by them: "Resolved, that the Vestry are of opinion the County Council have exceeded their functions in agreeing to proposals for over-riding the powers of the local authorities without affording them opportunities for considering such proposals, and that the Board of Trade, the County Council, the local authorities of the metropolis, and the members of the County Council for the Strand, be informed this Vestry approve of the objections urged by the Paddington and Chelsea Vestries against such transfer being made."

Liverpool Docks (Electric) Railway.—The contract for the Liverpool Overhead Railway Company has been let to Mr. J. W. Willans, of London, Liverpool and Manchester. This important undertaking is the first of the kind in England, though the type of railway is well known to our cousins in the New World. The total length of the railway is about six miles, and it runs parallel with the docks all the way. The structure is composed of iron girders, having a water-tight flooring for the whole length, and is carried on strong wrought-iron pillars. It is intended that the trains shall be worked electrically. The engineers are Sir Douglas Fox and Mr. J. H. Greathead.

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The Regeneration of Photographic Plates.—A curious phenomenon has been observed by Mr. J. Green, and was recently described by him before the London Photographic Society. Mr. Green believes that electricity is capable of restoring an exposed plate to its primitive condition; in other words, of making an old plate as good as new. If a plate which has been exposed is placed in a slightly acid bath, and if a current is then passed through the bath for a short time, the latent image is obliterated. The reason of this is not quite clear, although the result may perhaps be attributed to the formation of peroxide of hydrogen, which causes the obliterating effect.

The Provisional Orders in the House of Lords.—The Bills confirming the Provisional Orders granted by the Board of Trade for the electric lighting of London will, it is expected, meet with a somewhat strong opposition in the House of Lords. In the case of the Westminster and West-end Orders, a serious attempt will be made to throw out the Bills in Committee, on the ground that the consent of the local authorities has not been given to these Orders. With this object in view several petitions have been lodged in the Private Bill Office of the House of Lords praying to be heard against the Bills. The London County Council will also oppose these Bills, but their opposition is directed more to the clauses than the preambles.

Maidstone.—Mr. Wm. Webster has been in negotiation with the Maidstone authorities with a view to carrying out some extensive experiments with his electrical process for the treatment of the sewage. He proposes to carry out the experiments at a cost of £200, such sum to be paid by the town if the experiments are successful, but if not successful he will bear the cost himself. If Mr. Webster's process proves satisfactory he will then undertake to purify the sewage on an agreed sum per annum. The Local Board have agreed to fall in with Mr. Webster's proposals, and as the Local Government Board are applying pressure for some steps to be taken to prevent the River Medway from being polluted by the discharge from the town sewer, the work will be commenced without delay.

Atmospheric Electricity.—With a view of investigating more thoroughly the part played by atmospheric electricity in the formation of the nitrate compounds which exist in the air. M.M. A. Muntz and Marcano have for the last two years made, careful observations on this point at Caracas (Venezuela), where storms and electric disturbances are of great frequency and intensity. The conclusion arrived at by MM. Muntz and Marcano is that the extraordinary richness in nitrates which characterises the atmosphere in these regions can only be attributed to the very high electrical potentials usually prevalent and the frequent electrical discharges. Taking the annual rainfall of Venezuela at about one metre, the rain deposits something like 6·93 kilogrammes of nitrate per hectare (7lb. per acre), and is therefore a most valuable fertiliser.

The Pieper Semi-Incandscent Lamp.—M. Henri Pieper, jun., of Liège, has brought out a new type of semi-incandescent lamp. The lamp consists of two horizontal rods of copper, set in line with each other, but separated by a space of about $\frac{3}{10}$ths of an inch. A thin fluted carbon rod is set vertically, and rests upon the ends of the copper rod, forming a bridge across. The current passes through the copper rod and through the point of the carbon rod, which is thereby rendered brilliantly incandescent. The copper rods are supported on spring hinges, and if the carbon should break, they will rise slightly until two contacts at their outer ends come into action, thus automatically short circuiting the lamp. The wear of the copper rods is exceedingly slight, the carbon only being consumed. Some lamps of this type have been sent to the Paris Exhibition.

St. Margaret's and St. John's (Westminster) Vestry.—At a meeting of this Vestry, on Wednesday last week, Mr. Bowman Spink introduced a deputation from the City of Westminster Electrical Syndicate. The Clerk also read a letter notifying the intention of the company to apply for a license to supply electricity in the parish. They stated their willingness to light the streets at a price not exceeding the present cost of gas, to erect and maintain free of charge for twelve months lights at three important points in Victoria-street, to enable the Vestry to judge of the effect; and, should the Vestry so desire, to act as their Undertakers in respect of public lighting generally. The full capital of the syndicate was £20,000, and they had raised half that sum up to the present time. The consideration of the question was referred to the Parliamentary Committee for report.

Brighton.—At the last meeting of the Brighton Town Council it was resolved that the Town Clerk should request Mr. Shoolbred to meet the Gas Committee on an early day, with a view to his advising the Corporation as to the best course to pursue in order to provide a supply of electricity in the borough, whilst retaining for the Corporation complete control over the laying of mains and all work which would be executed in the public streets. It will be remembered that early in the year a Board of Trade inquiry was held, with the result that as Brighton had decided to supervise the electric lighting of the town, the Board of Trade did not see how they could dispense with the consent of the town in granting a Provisional Order for the Brighton Electric Light Company. The Council now find themselves compelled to undertake the business within two years, either by themselves or by letting it to others.

Electric Lighting Provisional Orders.—In the House of Commons on Friday last, in answer to Sir G. Campbell, Sir M. Hicks-Beach said that the formal consent of the Birmingham Corporation had been given to the Provisional Order for that town. The President of the Board of Trade further remarked that he would endeavour to arrange that in future either the formal consent of the local authority should be obtained, or that a special report should be made before the second reading of the confirming Bill. In the consideration of any future proposals which might come before him, he said that he would certainly take care that local authorities were not unduly harassed or hurried. It was with the very object of avoiding any such hurry that Parliament had enacted that notices should be given to local authorities on or before July 1 of all Provisional Orders applied for in respect of the ensuing Session of Parliament.

Lambeth Vestry.—At the last meeting of this Vestry the Clerk read letters from the Metropolitan Electric Supply Company, the London Electric Supply Corporation, the Electric Construction and Maintenance Company, and the House-to-House Electric Supply Company, giving notice of their intention to apply for Provisional Orders to supply electricity within the parish. He explained to the Vestry that at present two Orders had been obtained, one by the Metropolitan Company, and the other by the London Electric Supply Corporation. The former had entirely withdrawn their Order, and the streets included in the latter were only three, and the representatives of the company declined to take any further responsibility. He suggested that the matter should be referred to the Electric Lighting Committee, with power to present a petition against the London company's Order if they thought fit and proper to do so.—The suggestion was unanimously agreed to.

The Reported Atlantic Cable Combination.—"We (*Pall Mall Gazette*) are informed that there is no truth in the report that the Mackay-Bennet and the French Atlantic Cable Companies have entered into an amalgamation. As the latter company cannot even enter into a pool with the cable companies, it is obvious that it would be impossible for it to amalgamate. The visit of Mr. Ward, the New York manager of the Commercial Company, to Nova Scotia, had nothing to do with the question of amalgamation. The French company has landed its cable near Canso for the purpose of connecting with the Canadian Pacific Railway, which is now building lines in Nova Scotia. This gives the French Company a second route to the United States. As to the scheme of a new Anglo-Canadian cable with a guarantee from the Dominion, little heed is paid to it, as it is not taken seriously." For further information with regard to the last of these rumours we may refer our readers to the speech of Lord Tweeddale at the Anglo-American Telegraph Company's meeting, which we report this week.

The Preparation of Cellulose by Electrolysis.—When wood or any other similar substance is attacked by an acid, the mineral constituents of the fibre are dissolved, and the cellulose

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is precipitated; the latter is, however, mixed with complex organic compounds called "selmics," and in order to obtain pure white cellulose bleaching is necessary. It seems, however, that electrolysis affords a means of securing pure cellulose by one operation. Two vessels communicating with one another, and containing a 5 per cent. aqueous solution of chloride of sodium are filled with small pieces of wood. One vessel contains the anode and the other the cathode, the whole being kept at a temperature of 120°C. Under the action of the current the chloride of sodium is split up into chlorine, which goes to the cathode, and sodium, which goes to the anode. The nascent chlorine gives rise to hydrochloric acid and hypochlorous acid. The hydrochloric acid dissolves the mineral constituents and precipitates the impure cellulose. The hypochlorous acid takes away the colouring substances by oxidising the "ulmic" constituents, and is then transformed into hydrochloric acid, which saturating the free sodium, regenerates the chloride of sodium. As it is advantageous to submit the cellulose thus formed to the action of an alkali the current is reversed. The cellulose is then washed in acidulated water and the preparation is complete, the material being white and silky.

The British Association.—The British Association meeting will open on Wednesday, September 11th, at Newcastle, and the following is the programme at present agreed upon :—

Wednesday, Sept. 11.—Horticultural show. The President, Prof. Flower's, address, 8 p.m.

Thursday, Sept. 12.—Reading of Papers in the various sections, 11 a.m. Soirée, given by the Mayor and Corporation of Newcastle, 8:30 p.m.

Friday, Sept. 13.—Reading of Papers, 11 a.m. Lecture on the "Hardening and Tempering of Steel," by Prof. Roberts-Austen, F.R.S., F.C.S., 8 p.m.

Saturday, Sept. 14.—Reading of Papers, 11 a.m. Half-day excursions. Conferring of degrees at Durham University, 2 p.m.; and invitation luncheon to 200 members of the British Association, 3 p.m. Service in Cathedral, 4 p.m. Lecture to the working classes on the "Forth Bridge," by Benjamin Baker, Esq., C.E., 8 p.m.

The lectures delivered on Saturday evenings during the week of the meeting are intended solely for the working classes; they are not included in the proceedings of the Association, and members other than officials are not eligible for admission.

Sunday, Sept. 15.—Special services at the various churches in the City.

Monday, Sept. 16.—Reading of Papers, 11 a.m. Lecture on "How Plants Maintain Themselves in the Struggle for Existence," by Walter Gardiner, Esq., M.A., F.L.S., 8 p.m.

Tuesday, Sept. 17.—Reading of Papers, 11 a.m. Soirée, given by the Local Executive Committee, 8:30 p.m.

Wednesday, Sept. 18.—Concluding general meeting, 2:30 p.m.

Thursday, Sept. 19.—Whole day excursions.

No special invitation will be required to either of the soirées, but members will be admitted on presentation of their tickets.

The Recent Thunderstorms.—The storms of last week seem by all accounts to have been of a very destructive character. The storm of the 21st ult. was chiefly confined to the Eastern counties, although Oldham and the vicinity was visited on the same date by a very heavy thunderstorm, during which numerous houses were struck and greatly damaged, amongst the number being a house in Penn-street, on the Coppice. The lightning first of all struck the roof, knocking off the chimney pots and tearing up lead around the base of the chimney stack. It then went down the chimney and burst through the wall into the front bed-room. The bed room furniture was broken up and the pictures were shattered with such force that pieces of the frames were driven into the plaster of the opposite wall. The lightning then darted through the wall into the back bed-room, making a large opening in the wall, and descended by way of the back bed-room fireplace into the kitchen. At North Walsham 20 lambs were killed by lightning. At Lincoln a house in Saul-street was struck, and a fireplace was displaced and forced out half a foot into the room. On Tuesday last week Scotland and the Midlands were visited by a severe storm, accompanied in several instances by heavy snowfalls. At Auchterless a man was killed and several persons were badly injured. At Chellaston, on the same date, a row of five houses and a house adjoining were struck by lightning, which first descended on a stack of chimneys on a cottage at the opposite end of the row to the house. It dislodged the upper part of the chimney and a portion of the gable; the lightning then passed down the roof, knocking off the tiles in its path. On reaching the spouting, which it twisted out of shape, it continued its course for about 80ft. without damage until it reached an angle of the spouting, which was torn away. It then followed the spout for about 100ft. more without doing much damage except bursting two short water conductors and making a large crack in Mr. Domleo's house. The current then passed on still further, by a slaughter-house, to a covered roadway, seriously deranging one of the walls which support the roof, and descended by the water conductor to the earth, partly destroying the conductor in its passage. From the point at which the houses were first struck to where the lightning entered the earth was about 180ft. At Buckhurst Hill last week, during a storm, a carriage was struck in the Epping New-road, and the driver was killed. Storms of exceptional severity are also reported from other parts of the provinces.

The Electricity Supply Companies Registered during the Six Months ended June 30th, 1889.—The following is, to the best of our belief, a complete list of the public companies which have been registered at Somerset House during the period from January 1st to June 30th, 1889, and whose object is wholly, or in part, the public supply of electricity. We have divided the list into "General" and "Local" Companies, but it will be seen that the former includes several whose operations are apparently confined to a limited area. The total registered capital of the General companies amounts to £2,322,105, and of the Local to £1,059,000, amounting in all to £3,381,105 :—

GENERAL.

	Registered Capital.
Electric Construction Corporation	500,000
*Galloways	250,000
*Elmore's Patent Copper Depositing Company	200,000
*Priestman Brothers	150,000
*Mudge-Marchant Engine Company	131,105
Electricity Supply Corporation	100,000
Irish House-to-House Electricity Company	100,000
Lancashire and Cheshire House-to-House Electricity Company	100,000
Midland House-to-House Electricity Company	100,000
Northern House-to-House Electricity Company	100,000
Scottish House-to-House Electricity Company	100,000
South of England House-to-House Electricity Company	100,000
Western House-to-House Electricity Company	100,000
Yorkshire House-to-House Electricity Company	100,000
Electric Trust	60,000
Laing, Wharton and Down Construction Syndicate	40,000
*Northern Press and Engineering Company	30,000
Municipal Electric Light and Power Corporation	25,000
Planet Electrical Engineering Company	20,000
*Great Marlow Water Company	16,000

LOCAL SUPPLY COMPANIES.

Birmingham House-to-House Electricity Company	£100,000
Devon and Cornwall Electricity Supply Company	100,000
Liverpool House-to-House Electricity Company	100,000
Manchester House-to-House Electricity Company	100,000
Nottingham Electric Light and Power Company	100,000
South-Western District and Thames Valley Electricity Supply Company	100,000
Sunderland and District Electricity Supply Company	100,000
Cambridge University and Town Electric Lighting Co.	50,000
Newcastle-upon-Tyne Electric Supply Company	50,000
Newcastle and District Electric Lighting Company	50,000
Portsmouth and South Hants Electricity Supply Company	50,000
Wolverhampton Electric Light and Power Company	50,000
Bath Electric Light Company	25,000
Halifax Mutual Electric Light and Power Company	20,000
Northampton Electric Light and Power Company	20,000
Woking Electric Supply Company	20,000
Pontypridd Electric Lighting Company	10,000
Croydon Electric Supply Company	5,000
Keswick Electric Light Company	5,000
Brompton Electric Fittings Company	2,000
Kingston-upon-Hull Electric Lighting and Supply Co.	1,000
Leicester Electric Light and Power Company	1,000

* These companies have taken powers to supply electricity, though the fact is not indicated in the title.

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ON THE DISTRIBUTION OF ENERGY BY MEANS OF ALTERNATING CURRENTS.*

BY M. LEBLANC.

We will consider first the most obvious solution of the problem, which consists in the utilisation of the fact of the reversibility of ordinary alternate-current dynamos. We may suppose that the field magnets of the machine used as a motor are separately excited, or consist of permanent magnets; the self-induction of the circuit traversed by the alternating currents will then be very small, provided that the armature contains no iron, and the apparent resistance will not be much greater than its actual resistance. If we call I the intensity of the current in the armature, M the coefficient of mutual induction of the two circuits, and ω the angular distance through which the armature is displaced; then the motor couple F developed upon the axis will be given very approximately by the formula

$$F = I I^1 \frac{d M}{d \omega}.$$

In an ordinary alternator the armature consists of a number of pairs of bobbins identically situated around the circumference, and the field magnet presents an equal number of poles, alternately positive and negative, and are disposed in the same manner. Each time that the armature has turned through the angle which separates the axis of two consecutive poles, the coefficient M passes through the same series of values, but the sense in which the flux M I [the number of lines of force per pair of poles] traverses the armature has been changed. An equal variation of this flux will produce in the armature an E.M.F. equal and of contrary sign to that which was produced in the first instance. We can now write, in accordance with the first term of Fournier's series, $I \frac{d M}{d \omega} = \mu 1 \sin 2 \pi \frac{t}{T}$, where μ and I are two constants, T is the period—that is, twice the time which a coil takes in passing from one pair of poles to the next—and for $t = 0$ the axes of the coils of the armature coincide exactly with those of the poles of the field. In order that the couple F may always be of the same sign, it is evident that the variations of the current I must have the same period as that of $I \frac{d M}{d \omega}$. We can then write

$$F = \mu I A \left[\sin^2 2 \pi \frac{t}{T} \cos 2 \pi \phi - \sin 2 \pi \frac{t}{T} \cos 2 \pi \frac{t}{T} \sin 2 \pi \phi \right].$$

We see immediately that the mean value of this couple, the only one in which we are interested, will be given by

$$F = \tfrac{1}{2} \mu I A \cos 2 \pi \phi.$$

In order that a similar machine may be used as a motor, it is necessary that the variations of the coefficient of mutual induction of the field and the armature, and the current which traverses the latter, shall have the same period; that is to say, the speed of the motor must synchronise with that of the generator. And it can be shown that in order that the motor may tend to synchronise with the generator, it is necessary that the opposing couple upon its axis shall be less than $\frac{1}{2} \mu I A$.

Efficiency.—If R is the resistance of the armature and ρ that of the field-magnets, the quantity of heat disengaged per second in the system will be given by $\rho I^2 + \frac{1}{2} R A^2$. We here neglect the loss due to Foucault currents or hysteresis. Let us put $K = T \frac{d \omega}{d t}$, K being therefore a constant; the work done per second upon the axis of the machine will then be

$$\tfrac{1}{2} \frac{K}{T} \mu I A \cos 2 \pi \phi,$$

and the efficiency m is

$$m = \frac{K \mu I A \cos 2 \pi \phi}{K \mu I A \cos 2 \pi \phi + T (R A^2 + 2 \rho I^2)} \quad \ldots \quad (1).$$

In order to obtain a value for A, we have the following equation :—

$$E^2_0 = \left(R^2 + \frac{4 \pi^2}{T^2} L^2 \right) A^2 + \frac{K^2}{T^2} \mu^2 I^2 + \frac{2 K}{T} \mu I (R A \cos 2 \pi \phi + \frac{2 \pi}{T} L A \sin 2 \pi \phi).$$

In this expression E_0 is the maximum value of the E.M.F. Replacing the value of A from this expression in equation 1, we could get a numerical expression for the efficiency [the equation is, however, chiefly of use, in order to see in what direction the quantities vary]. We see immediately that the efficiency diminishes as the difference of phase ϕ approaches the value $\frac{1}{4}$—that is to say, as the output of the machine diminishes. As in practice we ought to prevent any sudden increase of the load, which, if it exceeds a certain limit, would arrest the motor without power to re-start, we shall be led to make the mean value of the angle ϕ tolerably large. We do not think it possible to obtain with synchronising alternators efficiencies as high as with continuous-current motors. On the other hand, unless, indeed, we employ permanent magnet machines, which are costly and cumbersome, the excitation of the field magnets presents many difficulties Lastly, there is the defect that these machines are not self-starting.

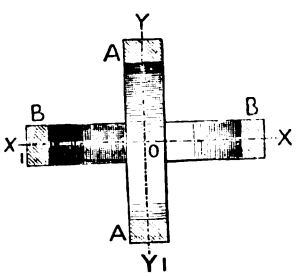

FIG. 1.

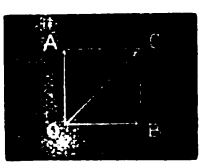

FIG. 2.

The Tesla Motor.—At nearly the same period Ferraris in Italy, Bosel in Switzerland, and Tesla in America, discovered an interesting property of magnetic fields when excited by alternating currents. Consider two concentric circular coils, A and B, making a right angle between them (Fig. 1). If we put through the coil A an alternating current, whose value is given by $I = J \sin 2 \pi \frac{t}{T}$, the magnetic force developed will be proportional to the current I_1, and will be directed along the axis O X. Now put through the coil B an alternating current having the same period T, but whose alternations differ by a certain phase ϕ. The intensity of the current can be expressed by

$$I_1 = J_1 \sin 2 \pi \left(\frac{t}{T} - \phi \right).$$

The magnetising force developed in the coil B will be proportional to I_1, and will be directed along the axis O Y, perpendicular to the axis O X. The resultant magnetic force developed at the point O will be equal at each instant to the resultant of the two forces directed along O X and O Y, and we can represent them in magnitude and direction by the right line O C (Fig. 2). If we trace the successive positions taken up by the point C during a period T, we find that the locus is an ellipse, having its centre at the point O. In the case where ϕ is $\frac{1}{4}$, the ellipse becomes a circle. The direction of the resultant magnetic force therefore rotates continuously around the point O. If we have ϕ equal to $\frac{1}{4}$, and if the magnetic permeability of the medium is the same in all azimuths, the result is the same as if we had a magnetic field of constant intensity continuously rotating around the point O. It is now easy to see that if we place a metallic disc between the coils A and B, so arranged as to be movable around an axis passing perpendicularly through O, this disc will be carried round by the rotation of the field as in the well-known experiment of Arago.

Mr. Tesla has applied this property to the construction of a motor which we represent diagrammatically in Fig. 3. A ring of iron wire divided into equal quadrants is wound with four equal coils, $a\, a_1\, b\, b_1$. The coils $a\, a_1$ are connected in the same circuit in such a manner as to develop in the ring two poles upon the line X Y. The coils $b\, b_1$ are connected in a second and

* Abstracted from *La Lumière Electrique.*

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independent circuit, and produce two other poles along the line X_1 Y_1, making a right angle with the line X Y. If we send an alternating current through the coils B B_1, the magnetic field developed in the ring will be constant as regards intensity, but its direction will be turned around the point O, and will make one revolution during the current period T. Mr. Tesla places in the middle of this field a drum armature, in which each coil is independent and closes upon itself. This is a remarkable machine; it has no sliding contacts, and it may be used with currents of high tension even when it is of small dimensions. The couple increases as the quickness of rotation diminishes, and its electrical efficiency can be made as high as we wish. It presents the inconvenience of necessitating a double set of conductors in order to provide the two currents differing in phase by $\frac{1}{4}$th. The apparent coefficient of self-induction of the system

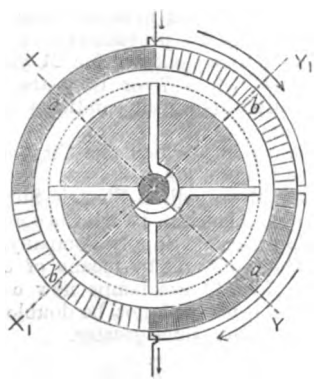

FIG. 3.

is smaller than the actual value, owing to the reaction of the armature. In order, however, that its output may be reasonably great in proportion to its size, it is necessary that the field due to the armature should be sensibly equal and of contrary sign to that of the field magnets. This condition it is impossible to realise. The actual size which a motor of this kind can attain is also limited by the effect of the enormous self-induction of the field. Finally, we do not think that the very interesting solution of Mr. Tesla will have any practical application, except, perhaps, for very small motors for domestic use.

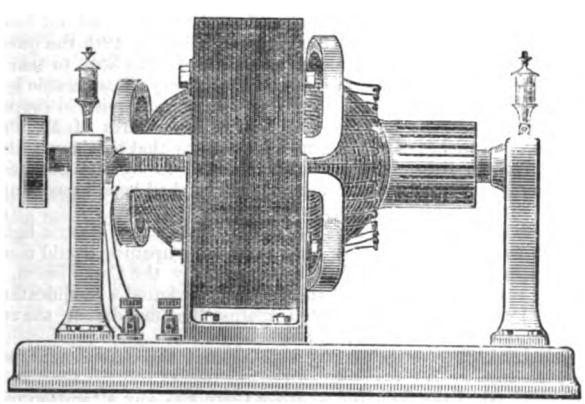

FIG. 4.

The Elihu Thomson Motor.—Prof. Elihu Thomson observed that if an electro-magnet, the coil of which was traversed by an alternating current, was placed opposite another electro-magnet, the coil of which was closed upon itself, the two mutually repelled one another. The outcome of this observation is the alternate-current motor shown in Fig. 4. In this machine, as in the Tesla motor, very high tensions can be used, since there are no sliding contacts. The apparent self-induction of the system is smaller than its actual value, owing to the reaction of the armature. Our personal experience has, however, shown us that the apparent resistance of machines of this type where supplied with currents of high frequency is far too great to allow them to be of much commercial value.

(To be continued.)

REVIEWS.

Munro and Jamieson's Pocket Book of Electrical Rules and Tables. Sixth Edition, Revised and Enlarged. (London: Charles Griffin and Co., 1889).

It is just five years since the first appearance of this invaluable publication, and since then no less than six editions have been demanded. This rapid succession of issues betokens not only the popularity and usefulness of the book, but also the determination of the authors to keep the contents as closely as possible up to date. The present edition, for instance, contains no less than 120 additional pages and 60 new figures relating for the most part to the latest developments of electrical engineering, and in particular to the applications of alternating currents. Amongst the new matter we may especially mention an excellent chapter contributed by Prof. S. P. Thompson, on the designing of dynamos, with remarks upon their installation and working, whilst Mr. Gisbert Kapp has a concise and useful Paper on transformers. Sir William Thomson's standard balances and Profs. Ayrton and Perry's sechommeter are each adequately dealt with. If any fault is to be found with this section, it is that the information is much more complete and exhaustive than would generally be looked for in a work one at least of whose *raisons d'être* is supposed to be its portability. If every subject referred to were treated upon the same liberal scale as these, the volume would speedily assume a bulkiness of aspect which would wholly belie its title. However, this is a difficulty to which probably the authors are already fully alive, and in later editions a judicious pruning will doubtless be applied in those sections wherein the losses will be felt the least. We do not mean to imply that the Sixth Edition itself is actually sinfully obese, but we do think that it approaches perilously near to that condition. The ultimate remedy will probably be a separation into two volumes, one for the Electrical Engineer and his compeers, and a second for the Telegraph Engineer, *et hoc genus omne.*

We pass on now to offer a few criticisms, more or less immaterial in character, but designed in response to the prefatorial request—a quite sincere one we are well assured—that any hints or suggestions for the improvement of the work may be unhesitatingly made known. To speak first of a minor point, we fail to appreciate the advantage of paging the new matter with the addition of an italic letter tagged on the number of the preceding page. We can only suppose that the authors wish to mislead the unwary into supposing that there are only 497 pages in the whole book, whereas the number positively exceeds 650! However, letting this pass, and coming to more important matters, we note that amidst a wide range of tables, many of which are of quite indispensable value, there are still some useful things which we seek in vain. For instance, we may reasonably ask for a table of current density per square inch, both for the Birmingham and for the standard wire gauge. Some dip and span tables for the erection of copper wire would be useful; indeed the whole section relating to overhead conductors other than iron might be considerably extended.

There is a valuable chapter by Prof. Ewing on Magnetic Measurements, containing a set of curves showing the relation between magnetising field (H) and magnetisation (I) for certain samples of iron and steel. We would suggest the desirability of supplementing this by further curves, both for wrought and cast iron, and for annealed plate and wire such as is most commonly used by the electrical engineer; and we would also add reciprocal curves showing the increase of magnetic resistance with the field intensity. The curves might perhaps be usefully supplemented with numerical tables. Some readers would no doubt like to have results in Kapp lines as well as in C.-G.-S. Such data as we here ask for would, it need hardly be said, be of immediate use in the design of dynamos, although it is perhaps true that careful men prefer to make their own preliminary tests upon the iron to be used.

Turning to another subject, we find the electric transmission of energy somewhat sparsely dealt with. There are several useful data and formulæ connected with this branch which might well find a place in these pages. The coefficients of traction which are likely to be met with in practice under given conditions should be recorded, and the simple formula for

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reckoning the power required to move a given load on a given gradient at a given speed. This kind of information would be of far more use than the equations of efficiency which are only applicable to the special case where generator and motor are of the same construction.

In the next edition we shall no doubt have Sir William Thomson's Tables (or the extension by Mr. Mordey) showing the actual resistance of conductors of given area with alternating currents of given period. It is, perhaps, a little premature to call for the revision of the section dealing with lightning conductors in the present divided state of opinion upon the subject, though, according to our own view, the advice tendered would bear supplementing, and, at least, the "area of protection" superstition should disappear.

We have only one other suggestion to make at the present moment. In the index we should like to see a separate subheading "Tables," in which all the Tables would be brought together in alphabetical order, so that it could be seen at a glance what information is given in tabular form. By-the-bye, we may mention here that on page 428 will be found the British Association standard small screw gauge, the adoption of which is now under the consideration of the Electrical Trades' Section of the Chamber of Commerce.

It is quite unnecessary that we should add, in conclusion, any words of commendation in respect of the general scope and merits of the book. It is sufficient to say that it has become as indispensable to the Electrical Engineer as "Molesworth" is to the older branches of the engineering profession

THE CONTRACTS FOR THE LIGHTING OF THE CITY OF LONDON.

The following report was presented to the Commissioners of Sewers at a meeting held on Tuesday, the 29th ult.:—

To the Honorable the Commissioners of Sewers of the City of London.

We whose names are hereunto subscribed of your Streets Committee, to whom on the 26th of February last it was referred to advertise for tenders for electric lighting, based upon the conditions then approved, do certify that in the first place we instructed the engineer and solicitor, with Mr. Preece, the electrician, to prepare the necessary form of tender and specification.

This having been done, and advertisements issued, tenders were received on the 10th of May from the undermentioned companies, viz.:—

The Anglo-American Brush Electric Light Corporation for the West and Central Districts.

The House-to-House Electric Light Supply Company for the Eastern District.

The Metropolitan Electric Supply Company for the Western District.

The Laing, Wharton and Down Construction Syndicate (East District).

The London Electric Supply Company (all three districts).

These were referred to the engineer and solicitor for consideration, with power to consult Mr. Preece thereupon, and the engineer, in conjunction with Mr. Preece, prepared an abstract of the said tenders.

In the meantime we received a copy of Major Marindin's report to the Board of Trade on the various applications for Provisional Orders and Licenses under the Electric Lighting Act, in which he says in regard to the City:—"The Commissioners of Sewers, acting for the Corporation, are endeavouring to obtain tenders for the lighting of the city; but I see no reason why the principle that all such lighting should be done under statutory powers and obligations should be departed from in their case, and the Commissioners have since received notices from the

Anglo-American Brush Electric Light Corporation,
Metropolitan Electric Supply Company,
London Electric Supply Company,
The Laing, Wharton and Down Construction Syndicate,

that they will in the next Session apply for Provisional Orders to supply electricity within the City of London."

We have also had before us a Model form of Provisional Order, prepared under authority of the Board of Trade.

On carefully considering the tenders sent in, together with the suggestions of the Corporation in regard to conditions, it was found that the tender of the Anglo-American Brush Company was the only one practically in accordance with the specification, and under the advice of Mr. Preece we instructed the officers to negotiate further with the Metropolitan Electric Supply Company and the London Electric Supply Company with a view to arrange similar terms with them.

This has since been done, with the result that they have severally modified the terms of their tenders, so as to bring them into uniformity with that of the Anglo-American Brush Company, and broadly all these three Companies now agree to accept the terms of the Provisional Orders now sanctioned by the House of Commons.

The prices per annum per arc lamp are as follows:—

London Electric Supply Company.....	£24	3	10
Metropolitan Electric Supply Company ...	26	0	0
Anglo-American Brush Corporation.....	26	0	0

But the London Electric Supply Company propose to extinguish half the lamps at midnight.

After full consideration, we beg to recommend that the tenders of the said three companies be provisionally accepted subject to their agreeing to enter into a contract for 21 years, determinable by either party at the end of 7 or 14 years, and the London Electric Supply Company waiving the condition as to extinguishing half the lamps at midnight.

That the three districts into which the City is divided for this purpose be allotted as follows, viz.:—

No. 1, West. To the Metropolitan Electric Supply Company.
No. 2, Central. Anglo-American Brush Corporation.
No. 3, East. London Electric Supply Company.

To light the main thoroughfares by means of 395 arc lamps will cost £10,024, in place of 1,730 gas lamps now costing £5,530 per annum, but whilst the price will not be double that of gas the amount of light will be many times greater.

DISCUSSION.

Mr. DAY (the Chairman), in moving the adoption of the report, said the cost of the electric light was of course greater than gas, but the result would be that the City would receive something like from four to six times as much light as now. One company proposed to turn out every other light at midnight, and Mr. Preece said there would then be as much light as with gas. There were a few minor points which it would be necessary for the engineer and Mr. Preece to arrange.

Mr. GREENWOOD asked which company it was that required half the lights to be turned out?

Mr. DAY: The Electric Supply Company.

Mr. MANNERS: That was not agreed to.

Mr. C. T. HARRIS did not think they were prepared to settle so important a matter that day. He moved that the report be printed and circulated, and its consideration adjourned.

Mr. GREENWOOD seconded the amendment. It would cost double the money, and the ratepayers should have an opportunity of expressing their opinions on it.

Mr. SHAW said there were occasions when it might be desirable to postpone the consideration of a question, but in this case he had not heard a single argument to justify their doing so. On February 19th the question was brought up, and a special Court was called on the 26th to take into account the whole matter. It was discussed at very considerable length and they had every information. A large time was occupied in preparing advertisements in such a form as would meet the desires of Mr. Preece and carry out the wishes of the Commission. To say that they must discuss this *de novo* was childish. The conditions agreed to by the Commission were the conditions on which the advertisements had been based, and on which these several companies were willing to do the work.

Mr. INNES said he was the last person to desire to stop electric lighting in the City, but he was not sure that all the companies would come in under the specifications which had been voted by the Commission. He was induced to think that some of the companies wanted a modification.

The CHAIRMAN voted, on division, against the amendment, the result being a tie—for the amendment, 22; against it, 22.

The CHAIRMAN gave his casting vote against the amendment, which was therefore lost.

Mr. INNES asked the Solicitor whether there was any alteration of any kind in the report between the terms agreed to by the Commission and the terms of the companies.

The SOLICITOR said he was not quite aware of the terms Mr. Preece had arranged. As a matter of fact, all the tenders differed from the original conditions.

Mr. INNES: Then in view of that statement I move that the debate be adjourned.

This was carried on a division by 24 to 20.

BOOKS, &c., RECEIVED.

Illustrated Catalogue. The Mutual Electric Manufacturing Company, Brooklyn, N.Y.

"*Journal* of the Institution of Electrical Engineers." Vol. XVIII., No. 81. (London: E. and F. N. Spon.)

"*Proceedings* of the National Electric Light Association at its Ninth Convention, held at Chicago." (Boston: *Modern Light and Heat.*)

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ON FREE IONS.*

BY W. OSTWALD AND W. NERNST.

(Concluded from page 301.)

The authors next go on to consider the subject from a theoretical point of view, and arrive at the conclusion that the above hypothesis would not only be in contradiction with the experimental results referred to by Clausius, but would lead to results inconsistent with the fundamental principles of Thermodynamics. They then reason as follows:—Imagine a metallic conductor in the form of a very thin horizontal circular disc mounted upon a vertical axis passing through its centre, and about which it can be made to rotate. Let one of the plates of a condenser be placed just above a portion of the disc and the other plate just below it, and let a definite difference of potential be maintained between the two plates. If the disc is then made to rotate, no work will be done in virtue of the electrification of the condenser, provided the motion is so slow that the development of heat in the disc, due to the motion of the induced charge within it, may be neglected. Now suppose the metal disc to be replaced by an electrolyte of the same form. Then if the ordinary law of electrostatic distribution holds for electrolytic conductors, the electrolyte also will absorb no work. On the assumption that when an electrolyte is charged electrostatically, work is absorbed in separating the ions, it can only be done at the expense of the heat of the surrounding fluid, so that the portion of the electrolyte which lies between the plates of the condenser must be cooled. On passing out of the field of electrical action, the ions will again unite and will then give out the same amount of heat. Thus we should have an apparatus capable, without expenditure of work, of establishing a continuing difference of temperature, a result in contradiction with the second law of Thermodynamics. The authors then ask us to imagine a metallic sphere surrounded by a concentric sphere of liquid electrolyte, and separated from it by an insulated layer of air. This metal sphere is to be supposed capable of being charged positively or negatively at will, while the hollow liquid sphere of electrolyte must be imagined to be connected with a sufficient mass of the same solution for its potential not to be sensibly affected by charging the metallic sphere. If a definite charge is then given to the metallic sphere an equal and opposite charge will be induced upon the surface of the hollow sphere, assuming as before that the electricity carried by the free ions distributes itself according to the ordinary law of electrostatics. It is easy to test this reasoning by experiment, for if there is not a charge upon the inner surface of the outer sphere equal and opposite to that of the metallic one, the hollow electrolytic sphere will not screen external space from the electrical action of the charged sphere. To determine whether a layer of electrolytic liquid has such a screening effect or not, the authors made the following experiment:—A zinc case was constructed upon a wooden framework within which was placed a small influence machine. In one of the vertical sides of the case a circular opening was cut and filled up with filter paper soaked in hydrochloric acid and pressed between the plass plates. On either side of these plates were placed metal discs, 25 centimetres in radius. The disc within the case was then connected with the terminals of the influence machine, and the other with a Hankel gold-leaf electroscope. The other terminal of the machine was connected to the case, which was put in connection with the earth. The electrolytic layer was earth connected by means of an unpolarisable electrode, consisting of mercury covered with a solution of mercuric chloride. It was then found, as was anticipated, that when the machine was worked and the connections with its terminals interchanged no effect was produced upon the electroscope, although the sensitiveness was such that if the screening had been imperfect by one part in ten thousand an effect would have been observable. The hypothesis that the separation of the ions only take place in consequence of the electrification is therefore untenable, and we are entitled to regard the system as determined by two variables, namely, the absolute temperature T and the electrostatic charge E of the metallic sphere, provided that the change in E is not sufficiently rapid to give rise to changes in the concentration of the liquid, and that the development of heat due to the motion of the electricity is negligible. Let a quantity Q of heat be added to the system and be expended in increasing the internal energy U and in doing internal work, then

$$dQ = dU + a\,E\,dE \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where a is a constant depending upon the dimensions of the system. In the special case considered here its value is $\frac{D}{R(R+D)}$ where R is the radius of the metallic sphere and D the thickness of the layer of air between it and the hollow sphere. The work done in increasing the charge from E to E^1 will be, according to Clausius (Poggendorff's *Annalen*, Vol. LXXXVI., p. 337), $\frac{1}{2}(E-E^1)^2 a$. Equation (1) may be written in the form

$$\frac{dQ}{T} = \frac{1}{T}\frac{dU}{dT}dT + \frac{1}{T}\left(\frac{dU}{dE} + a\,E\right)dE \quad . \quad . \quad . \quad (2)$$

And according to the second law of Thermo-dynamics $\frac{dQ}{T} = dS$ is a one-valued function of T and E, and therefore

$$\frac{dS}{dT} = \frac{1}{T}\frac{dU}{dT}; \quad \frac{dS}{dE} = \frac{1}{T}\left(\frac{dU}{dE} + a\,E\right).$$

Differentiating these two equations with respect to E and T we obtain :—

$$\frac{d^2S}{dT\,dE} = \frac{1}{T}\frac{d^2U}{dT\,dE};$$

$$\frac{d^2S}{dT\,dE} = -\frac{1}{T^2}\left(\frac{dU}{dE} + a\,E\right) + \frac{1}{T}\frac{d^2U}{dT\,dE}.$$

Again, $0 = \frac{dU}{dE} + a\,E$, and substituting in equation (2) we find $dQ = \frac{dU}{dT}dT$, or if we suppose the process to take place isothermally, $dQ = 0$; that is to say, no work would be required to separate the molecules into their ions, and we may conclude generally that the ions which participate in the conduction of the current are in a state of free motion. The requirements of the mechanical theory of heat thus lead to the hypothesis of Arrhenius. The authors then restate as follows the theory of electrolysis from their point of view. Suppose we have an electrolyte having the potentials at two surfaces within it maintained at the potentials $+v$ and $-v$. The first effect produced, in accordance with Ohm's Law, will then be an electrostatic distribution of potential, varying from $+v$ to $-v$ upon the surface of the conductor, consisting, as before pointed out, in a distribution of positive and negative ions respectively over the surface. There will therefore be, as Kirchhoff pointed out in the case of metallic conductors, a force acting upon the electric charges in the portion of liquid included between the two surfaces in such a direction as to drive the positive charges one way and the negative charges the other. In electrolytes, however, the charges are united to the ions, and the forces upon the two being equal will set them in motion with a velocity which will be inversely proportional to the frictional resistance to which they are subject. The quantity of electricity transferred in unit time will, therefore, be proportional—

1. To the difference of potential.
2. To the number of free ions.
3. To the sum of the migration velocities of the ions.

This is the essential condition of electrolytic conduction, and is exemplified in the case of a closed electrolytic conductor in motion in a uniform magnetic field, when the work done against electrodynamic forces will appear in the form of heat in the conductor. In the case of a system consisting of both metallic and electrolytic conductors, the electricity on reaching one of the metallic surfaces will pass on in some manner which is as yet unknown to us, but is probably not very dissimilar to electrolytic conduction, while the ions will remain behind in the electrolyte, and being incapable, after losing their charges, of separate existence, will either unite with other ions, or will decompose the solution and form fresh compounds. The passage of the electricity from the ions to a metallic conductor requires a certain minimum difference of potential. As long as this is not attained, the system consisting of metal and electrolyte will act like a condenser, similarly charged atoms accumulating at a given surface of separation, which would give rise to an opposite electrification on the inner surface of the metal, and allow electricity similar to that on the ions to flow away. Now we know that the smallest E.M.F. is capable of starting an electrolytic current, but this will only continue until the condenser is charged, and will cease when convection ceases to take place. These conditions are fulfilled at each pair of separating surfaces of the metal and electrolyte, and determine the polarisation. The theory then leads to the known experimental result that as the E.M.F. of the primary current increases, the E.M.F. of polarisation will also increase to a certain maximum value, namely, until the electrical double layer is completely formed. When the primary E.M.F. is further increased a transference of electricity will take place from the ions to the metals, corresponding to the spark discharge of a condenser. If the metallic surfaces or electrodes are metallically connected, while in the stage of polarisation, so as to equalise their potentials, there will no longer be a force acting upon the ions tending to drive them in opposite directions, and therefore they will begin to approach each other and unite again, so that the electrification accumulated on the electrodes by the condensing action will be set free and equilibrium will be established through the metallic connection.

* "Zeitschrift für physikalische Chemie." Vol. III. Abstracted from separate impression communicated by the authors.

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The Electrician.

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ALTERNATE CURRENT WORKING.

The discussion on Mr. MORDEY'S Paper on Alternate Current Working, read two months ago before the Institution of Electrical Engineers, has just been published in the recently issued number of the *Journal*, and as each speaker has presumably had the opportunity to revise and condense his remarks, and as we print in another place Mr. MORDEY'S reply, the present moment is a convenient one to review the discussion and endeavour to see how far the scientific horizon has been widened by the various opinions so expressed. Most of the principal speakers, from the President downwards, bore testimony to the practical worth of Mr. MORDEY'S contribution. We do not think that these remarks were merely complimentary, but that those who so spoke sincerely considered that the Paper was a valuable and practical donation to electrical knowledge. The Paper had in it all the good elements which a memoir of this character should have. It summed up very fairly existing knowledge, it stated clearly some definite views formed by the author, and, more than all, it described successful and highly important experiments on the parallel working of alternators, which were repeated again a few days later in the presence of a party of engineers and experts assembled at the works of the Brush Company. Reviewing, however, both Paper and the discussion, we cannot but feel conscious that the problems with which this Paper deals are not yet generally solved, and that we are still in the period

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when notions of various kinds respecting them are fermenting in many minds, but that the process of converting these more or less nebulous ideas into sharply-cut definite conceptions and practical rules is yet incomplete. Put more definitely, what this amounts to is somewhat as follows:—Six or seven years ago, although even before that time Mr. WILDE had shown the possibility of running alternators in parallel, electrical engineers may be said to have been almost universally of opinion that alternators could not be got to work practically in parallel. Dr. HOPKINSON'S published Papers in 1883, and his experiments jointly with Prof. ADAMS in 1884, may be considered to have destroyed the merely negative opinion, and to have demonstrated that certain types of alternators could, and did under certain circumstances, work in parallel. Since that time we have had many more or less similar successful experiments effecting the same thing, not merely in the form of workshop experiments, but in the actual work of a central station. Those whose interests lie rather in the direction of the development of direct current working are very strong in the opinion that these attempts have never got beyond large scale workshop experiments, but on the other hand, we have other engineers of repute who claim, as does Mr. ZIPERNOWSKI, on behalf of Messrs. Ganz and Co., that they have alternate current machines running in parallel in a thoroughly satisfactory manner, with widely varying loads, in central stations in Rome, Livorno, Frankfort-on-Main, and Marienbad. The previous experience, however, which is well set out in Mr. MORDEY'S Paper, amply justifies the view that the general principle on which the successful running-in-parallel of alternators depends had not been previously arrived at or displayed, and that the accomplished facts had been only of the nature of demonstrations that certain types of alternators could run together, but had not established any rule for guidance as to how to go to work to construct machines which should certainly do this. This is really the important matter. The practical dynamo builder does not care two straws whether the mystery of parallel running of alternators has or has not been packed up in somebody's mathematical equations to be extricated therefrom subsequently as from a conjuror's inexhaustible bag, nor does he derive much valuable guidance from the differences of experts, some of whom consider the secret depends upon abundance of self-induction in the armature, and some of whom think it does not. The dynamo designer pondering over the present and the past, and looking to the requirements of the future, "wants to know" exactly what are the conditions to be complied with in order to construct alternators which shall successfully perform this act. And, moreover, he desires this information to come to him in the form of definite guiding scientific principles and practical rules, and not merely to be told that machines, as built by some particular firms, will run in parallel together, whilst those as built by others will not do so. Mr. MORDEY took up a perfectly definite position in his Paper in submitting the view that a perfect alternator for all and every purpose should have no resistance and no self-induction. In his reply he has laid a little more additional stress upon a point which is undoubtedly of very great importance, namely, the "stiffness" of the magnetic field, and he accuses the mathematical theory of having neglected to take this into account. If these had been merely opinions based on the special knowledge of a dynamo designer of great experience they would no doubt have been received with attention; but Mr. MORDEY has done far more than this—he has proceeded to embody them in a material form, to build alternators with strip armatures of small inductance and resistance, to place them in very strong magnetic fields, and to give the most convincing proof of the excellence of this arrangement in producing mutually controlling alternators. Some of his critics, whilst giving him all praise for his experiments, dispute the validity of the reasons which he assigns for his success. First came Dr. HOPKINSON, who decides that the alternators will best control each other when the "time-constant" or quotient of the self-induction by the resistance of the armature circuit is a definite fraction (nearly one-sixth) of the complete periodic time of the machine, and that accordingly a little self-induction in the armature is sometimes a benefit. In order to test this theory it is absolutely necessary to possess measured values of these three factors for machines which have been found to work in parallel well, or the reverse in practice, and the collated figures would be of immense assistance in proving or disproving the theory.

Mr. KAPP entreated his audience not to allow themselves to be influenced by Mr. MORDEY'S attempt to use the successful experimental facts in upsetting a well-established theory. Considering how very wide the differences of opinion on the alternator theory are, it can hardly be spoken of as "well established," or it would surely be less the subject of difference in debate than it is. Mr. KAPP claimed as proof that Mr. MORDEY'S armature was not free from self-induction, or its equivalent, the striking experiment of running in parallel the machines at 2,000 and 1,000 volt excitation respectively. At the end of the evening Sir WILLIAM THOMSON, however, gave a different view of this experiment, and his remarks, which were naturally listened to with great attention, carried, we think, conviction to the minds of those who heard them that the reaction of the armature currents upon the magnetism of the fields is at the bottom of this striking experiment. Mr. SWINBURNE joined Mr. KAPP in deprecating what he called Mr. MORDEY'S attack on existing theory; but, as we have said above, theory in the sense of an actual explanation of observed effects, or a power of predicting fresh facts, does not at present exist, and his reasons for thinking that the 2,000 and 1,000 volt experiment argues large self-induction are best disposed of by reading attentively the President's remarks.

Prof. S. P. THOMPSON touched more nearly the vital point, also briefly alluded to by Dr. FLEMING, viz., the relation of the stability of synchronisation upon the armature inductance. He did not agree with Mr. KAPP that this stability depended upon self-induction, at least in the armature itself. Prof. AYRTON contributed one valuable element to the discussion by giving the actual measurement of the self-induction of the Mordey armature in various positions *in situ*. Armed with his secohmmeter and aided by his corps of ever faithful students, he was able to so far sit in judgment on a portion of the case as to decide the armature inductance to be about one-thirtieth of a secohm. If he could carry out a large campaign against all sorts and conditions of alternators and obtain the three factors of armature resistance, inductance, and periodic time, we should have the materials in hand for some very valuable discussion. These and such-like quantitative experimental researches are the only stepping stones likely to promote real progress.

Let us look for one moment from what may be called the purely common sense point of view at the conditions which are likely to be required to be present in order that two alternators may keep step together. The machines being supposed to be initially in step and independently driven, let one of them now begin to lag behind. In order to bring it up again into step it requires to be rapidly and effectively converted into a motor—that is, the lagging machine must drop its character of current generator and take upon it the function of motor whereby it is brought up again into step and then resumes its *rôle* of current producer. Not only must there be great promptness in the assumption of the motor function the moment any sensible lag occurs, but the motor character must

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be very pronounced; the machine must, as it were, transform very quickly from a good dynamo into a strong motor. In this way the very attempt at lagging is checked promptly. The machine must not dally with the danger, or linger until the lag has increased to such an extent as to reverse the sign of the electro-motive force of the lagging machine relatively to the other. The lag is to be looked upon as a sort of disease which imperils the steadiness of the mean electromotive force in the external circuit, and the machines must automatically, promptly, and vigorously apply the proper remedy. It does seem to suggest itself that a disposition so to do this requires two conditions — first, that nothing shall hinder more than necessary the reversal of the current in the armature circuit. Small time-constant is not the only element, however; we must have, secondly, a "stiff" magnetic field, or one on which the armature current produces by its reaction very little effect. The reversed armature current must be coupled with the rigid magnetic field, or else the armature has nothing as it were to pull against. The would-be mountaineer on an ice slope requires to find a strong and unyielding arm or rope to hold on to in order to recover from a slip of the foot, and the rigid magnetic field is that which the back-slipping armature grasps at in order to recover its lag. This is virtually Mr. MORDEY'S theory. It may be that subsequent knowledge will modify it, but it looks at first sight as if it would hold water. Those who differ from Mr. MORDEY, and who fight under the other banner, and think that a good deal of armature self-induction is essential to success, should now, if they can, produce measurements or facts to show that a diverse set of conditions will produce the same result. It does not follow that alternators with iron-cored armatures and having large self induction are in any way at a disadvantage. They may have a higher internal resistance, and sensibly the same relation of time-constant to periodic time, whilst possessing also the other necessary condition.

Summing up all the discussion, we may say that, although we have not yet arrived at that useful and simple generalisation of experience for wh ch we are waiting, we have yet had the ball set rolling and sufficient diversity of ideas expressed to make it evident that the chief pitfall to be avoided is haste in stereotyping our views. We should endeavour to prevent ourselves from being put in bondage to words, and by an energetic collection of experimental data endeavour to ascertain what are the practical conditions to be complied with to produce alternators which, when put together in parallel, are strongly co-phasial synchronisers. When this is done it will create no more surprise to see a battery of a dozen alternators run in parallel than it does now to see a batch of continuous current dynamos so worked. Present success is an earnest of such future achievement, and the differences of opinion which the present debate reveals will be settled once for all only in the light of such accomplished facts.

OBITUARY.

JAMES CLARKE BEY, C.M.G.

The death is announced of John Charles James Clarke Bey, C.M.G., Superintendent at Alexandria of the Egyptian Government Telegraphs. He was 43 years of age, and had been employed, says *The Times*, in the service of the telegraphs of the Khedive for many years at Zagazig, and more recently at Alexandria. In 1882, when the rebellion of Arabi Pasha occurred, he offered his services to the British Admiral, and being a good Arabic scholar and well known to the Bedouin, was employed from July 29 to September 25 upon many important secret missions in connection with the Intelligence Department. By his knowledge of telegraphy he prevented any news of the landing of the British troops at Ismailia from reaching the ears of Arabi, and he succeeded in obtaining a quantity of railway trucks and engines to convey our troops into the country. On September 13, the day of the battle of Tel-el-Kebir, when he was attached to the Indian contingent under General Macpherson, he seized the telegraph office at that place, went on to Zagazig, and there ascertained that 15,000 rebels were at Salieh with 26 guns, and that they were within an hour and a-half by train of Zagazig. As delay was now most important to the British troops, Mr. Clarke entered the telegraph office, obtained the private signals, and found out that two trains containing about 5,000 troops were waiting at Aboukebeer for the signal to come on to occupy Zagazig, and that others were getting ready. He telegraphed to Aboukebeer, "Two engines in collision at the junction, line not clear." This gave General Macpherson, who only had 70 or 80 men with him, time to send them forward and tear up part of the line. He subsequently telegraphed to the commandant of those troops to fall back. For these and similar services he obtained the war medal and clasp, the star, and was created a Companion of the Order of St. Michael and St. George; and from the Khedive he received the Fourth Class of the Imperial Order of the Medjidieh. In 1886 he was created a Bey.

ALTERNATE CURRENT WORKING.*

The following is the full text of Mr. Mordey's reply to the discussion on his Paper on "Alternate Current Working," the authorised abstract of which we published in our issue of June 7th:—

I wish in the first place to express my thanks for the very kind way in which you have received this Paper. The criticisms have, in some cases, been answered by other speakers. The remaining points in regard to which the speakers are not in accord with me I must deal with so far as I can in the time at my disposal, but I need not occupy time by referring to other matters.

Dr. Hopkinson's statements on electrical subjects are always received, not only with great respect, but as being usually correct and final. I join in the respect, but venture to question the correctness in this instance. If Dr. Hopkinson would be better satisfied by my stating that the most perfect alternator conceivable is one which has an indefinitely small self-induction and resistance, I am quite prepared to express my meaning in that way. I was acquainted with the general practical results, as regards parallel working, brought before us in 1884 by him, but, for reasons which will be understood, I did not derive any assistance from his theory, nor do I now agree that that theory "is sufficient to predict all the results obtained." I cannot fully argue this point, but must ask Dr. Hopkinson if he will kindly look into it again, for I am strongly of opinion that he will find it is not as complete as appears to be supposed. I am the more convinced of the correctness of my explanation by the measurements of the self-induction of my armature by Prof. Ayrton's assistants, using the new Ayrton and Perry instruments, and by the statement made by Prof. Ayrton that the time-constant, or ratio of the self-induction to the resistance, was about the same in my machine and in that of an alternator of another maker, which latter machine only exhibited very feeble synchronising properties when attempts were made to run two of them in parallel.

The point where mathematical treatment of the subject appears to have failed is that it has not taken sufficient account of the "stiffness" of the field. This is at once apparent when this measurement of the self-induction of one of my machines is referred to, from which it will be seen that the self-induction was practically the same whether any impressed field existed or not. Manifestly, with no impressed field, the controlling power of the machine would be quite inconsiderable, although the values of self-induction and resistance—upon which Dr. Hopkinson relies—would be the same then as when the machine was working with a strong impressed field, and under the conditions giving the maximum generating and controlling power. Hence it is evident that a theory which only takes cognisance of self-induction and resistance must be altogether illusory.

There are several reasons for the view that his theory is incomcomplete. His paper has been before the world for several years, and has been often studied, but neither its author (who has been engaged on the subject) nor anyone else has ever based any practical advance on it. Working parallel has been recently considered,

* From the *Journal* of the Institution of Electrical Engineers.

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as a question of great urgency and importance, before this Institution and elsewhere, and there have been abundant opportunities for bringing forward any useful information; but the whole subject was misunderstood, and Dr. Hopkinson, who has been a witness of the struggles that on all sides were being made towards a better understanding of it, has remained silent. I am sure that nothing would be more unlike him than to let the whole industry suffer for want of a little clear and definite information, if he had been able to give that information. Dr. Hopkinson even took part in the discussion on Mr. Kapp's Paper a few weeks ago, and threw no light on this question, thus tacitly subscribing to the current views.

It would be easy to find several other instances, besides those mentioned in the brief enumeration in my Paper, to show that the views generally held were entirely misleading and incorrect. For example, Mr. Swinburne alludes to* Dr. Hopkinson's mathematical treatment, and says that he has put the matter into English in his book;† and I find in that (recently written) book it is stated (on p. 151) that there are no alternate-current motors. But nothing less than the actual words can show how completely misleading this theory was. Mr. Swinburne proceeded, in the book in question: "It seems generally to be assumed that the only difficulty with alternating-currents motors is to start them. It seems probable, however, that there will be very great difficulty in designing a motor which will work with reasonable efficiency and varying load. An alternating- is a widely different thing from a direct-current motor."

Having seen all these statements disproved—having seen a 50 horse-power synchronising motor running with high efficiency under varying load, and designed on the lines of a direct-current motor—Mr. Swinburne now comes forward and says:‡ "I see nothing in Mr. Mordey's interesting experiments which conflicts with the recognised theory; in fact, *the position of synchronous motors is not altered*"—the italics are mine. Truly the Hopkinson theory, as rendered into English, must be capable of infinite elasticity.

Then again, only a few months ago, Mr. Swinburne, who had assimilated this theory, stated§ that such machines as mine would not run in parallel at all, and he described an "induction coupler" which he had devised for the purpose of making them so run by inserting self-induction. That device is a very good illustration of the results of the old theories. I may mention that when I was labouring in the slough of those old theories I independently devised that identical arrangement, which is one quite in accord with the requirements of those theories, so far as I was able to understand them; and having entirely failed to get two ironless alternators of a well-known type to work parallel in their simple condition, I tried that "induction coupler," without any improvement in the result. That was, in fact, one of the experiments that opened my eyes to the whole fallacy. It helped me to see that anything that prevented the instantaneous passage of the necessary correcting current must inevitably tend to prevent synchronous action.

Referring to Prof. Adams's criticism, I may say that I was fully aware of his experiments at the South Foreland Lighthouse, and referred to them. Prof. Adams considers those experiments as conclusively establishing Dr. Hopkinson's theory. I need not again consider them in that connection, but would only say that the motor effects obtained were not powerful, and that they have not been taken as forming a basis for practical construction. Indeed, they have remained on record as the not very high tide-mark beyond which no substantial advance was found practicable until machines having very different qualities were developed. It would cause me no surprise to find that the South Foreland experiments succeeded from quite different causes than those imagined by Prof. Adams. It is not at all clear that any of the advocates of Dr. Hopkinson's theory really understood what that theory is. It seems to cover a multitude of quite opposite interpretations, and resembles some of the Hebrew prophecies in its comprehensive applicability to occurrences—after the event. Prof. Adams, I am afraid, rather supposes that I make some sort of claim to having introduced parallel working. The object of the first portion of my Paper was rather to state what lines I thought should be followed in order to obtain the best results, and to show that on those lines complete success could be attained at a time when, in spite of Prof. Adams's well-known and valuable Paper, considerable and well-founded doubt existed as to the commercial possibility of parallel working. In one respect, however, I am quite unable to follow Prof. Adams, and that is in some of his analogies between alternators working parallel and tuning-forks vibrating in unison. He says that I gave the octave when I had one machine working at 1,000 volts and the other at 2,000 volts, both being at the same speed, and he suggests that I should give the double octave, and various other ratios. Now I fail to see that there is any true analogy between various rates of sound vibration produced by tuning-forks and corresponding ratios of electrical pressure. It would be just as correct to say that a steam boiler with a pressure 120lb. on the square inch was giving the octave of another boiler working at 60lb.

As to the very different problem of running alternators parallel when the alternations are an octave of one another—a possibility that is also put forward by Prof. Adams, and which has been mentioned to me by Mr. Sumpner and others—I can only say that I have not tried it, partly because it does not hold out any promise of a useful result if successful, and partly because I feel pretty sure it would not succeed, except with machines having so much self-induction as to render them unsuitable for practical purposes. A little consideration will, I think, show that this must be the case.

Prof. Adams refers to the loud humming noise made by my alternators when they were connected parallel while out of phase as "very sufficient evidence of very considerable self-induction, in consequence of which the speed of one machine is suddenly increased, and of the other as suddenly diminished." This noise is really a proof of the contrary. It is caused by the enormous rush of current which the comparative absence of self-induction renders possible, and this momentary rush puts the machines in phase with a jerk. As bearing on this point, I may mention that some machines that are said to have large self-induction do not make this noise under the same circumstances. Their self-induction prevents any such rush of current, and, according to my view, also prevents their working parallel. Although dissenting from my explanation, this rush of current is recognised by Mr. Swinburne as a proof of absence of self-induction.

It is interesting and important to consider another action arising out of this matter. In several machines—some with and some without iron—the self-induction is so serious that it does as well to short-circuit armature coils as to cut them out when it is desired to reduce the potential difference at the terminals. In fact, these machines cannot be injured by accidental or intentional short-circuits. They obtain this advantage, however, at the cost of every other good quality. The rush of current, the effect of which Prof. Adams noticed, but misunderstood, in my machine, could not take place with such high self-induction machines. They could be put into connection when out of phase, and would simply choke back the current which attempted to put them into step.

I think there is no real difference of opinion between Major Cardew and myself on the subject of safeguards. I quite agree with him that the two contacts *a* and *b* may be "ready waiting" for a person to make the other two contacts and so receive a shock. It is to prevent the possibility of this that I so strongly recommend earthing. It is an absolute safeguard, costs nothing, and does not cause interference with the telegraph or telephone service. I cannot admit that it increases fire risks. I think it lessens them, because it makes it certain that a faulty transformer or house circuit cannot remain on. The safety fuse on an earthed circuit instantly cuts off a faulty house, and so prevents that gradual accumulation of unsound or actually defective places that, without some such safeguard, would soon render a large supply service unworkable. As to the supposed excessive strain on a 100-volt circuit if it is earthed, that does not exist in practice. The secondary is earthed in the middle, so that the strain is really only 50 volts; and an installation that will not stand that strain is radically bad and ought not to be allowed anywhere. The great advantage of earthing is that it secures safety, protects the customer against bad work and leakage through his meter, and protects the system against the presence of rotten installations. If the fire offices do not see before long that earthing does not increase fire risks, I shall be greatly surprised.

One or two points in Dr. Fleming's remarks require some reply from me. His suggestion to account for the behaviour of transformers with different periodicities is, I think, very pretty and very ingenious. At first I could not fully accept it, as the greater penetration of the eddy currents into the iron at a low periodicity seemed to be an effect that would not be likely to be felt with very thin conductors such as the laminated iron; but I now see that the currents in the laminations, although very close together and insulated from each other, can act on one another and produce the "virtual resistance" effect.

Prof. Fleming's objection to my substitution of the word "magnetisation" for "induction" is not a very strong one. I have only to say that I think "induction" would not be a good word even if it had not already been secured for a dozen other purposes. Some limit should be placed to the multiplication of meanings given to this one word, which, after all, is not an electric or magnetic word at all.

Mr. Kapp has latterly given much attention to this subject of alternate-current working, and understands its difficulties. On this account and also because I was obliged to strongly oppose some of his views, I highly appreciate his kind remarks about the Paper. He accepts all my facts, but rejects my interpretation. He will, I feel sure, accept them both on further consideration.

The experiment of which he suggests an explanation, which is in some respects similar to the explanation proposed by Sir William

* *The Electrician*, June 14th, 1889, p. 154.
† "Practical Electrical Measurement."
‡ *The Electrician*, June 14th, 1889.
§ *Journal*, Vol. XVII., p. 401.

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Thomson, is no doubt a very interesting one. It is a case not very likely to occur in practice, but deserves attention. I do not, however, quite agree with Mr. Kapp and Sir William Thomson. I wish their explanations were more convincing, and were not so much opposed to Prof. Ayrton's measurements of the self-induction with different relative positions of armature and field, and with various field strengths, which showed that the actual conditions are exactly the reverse of those relied upon in Mr. Kapp's supposition.

I think that in any case the actual magnetising or demagnetising action exerted by the armature on the field magnet must be small, partly for the reason, pointed out by Prof. Silvanus Thompson, that there was not time in a half-period for the solid iron to undergo any change, and partly because the armature is purposely made so as to exert as small an effect of that kind as possible. The machine consists of a very powerful electro-magnet, the field; and a very weak electro-magnet, the armature Even if coils similar to the armature coils were wound on the extremities of the polar horns, and had a direct current sent through them equal to the maximum working alternate current, they would not produce a very powerful effect on the field.

One of the difficulties met with in considering this question is that there is no means of knowing which machine was generator and which motor. This depends, of course, upon the relative power of the engines. It is quite possible that the lower E.M.F. machine was acting as the generator.

I can only say that I will take the first opportunity of acting on Sir William Thomson's suggestion as to testing the supposed changes of magnetisation, and hope thus to be able to settle this question.

Mr. Swinburne challenges my conclusions on several points with his usual vigour, and I very willingly take up the gauntlet. I have already alluded to some remarks of his which place him in the honourable light of an interpreter of Dr. Hopkinson's mathematics. The position is one that requires great powers of endurance and considerable courage.

Mr. Swinburne says that "electrical engineers do not realise what is wanted in parallel running." I accept this candid statement as, at any rate, quite correctly describing his attitude in the matter; and am therefore, of course, prepared to find that he disagrees with most of my views.

He commences by stating that so far from the motor being kept in step because its self-induction was small, that, if there were no self-induction, the generator would have no control at all over the motor.

This is an instance of a very common mistake—that of supposing that if there is practically no self-induction there can be no generating or motive capability. The exact contrary is the case, as I tried to explain in the Paper when I expressed the view that "a perfect alternator for any and every purpose should have no resistance and no self-induction." Of course this condition is unattainable in practice. It is a mere expression of the direction in which it appeared desirable to advance; and, as I have already said, I am prepared to put it that the most perfect alternator conceivable is one which has an indefinitely small self-induction and resistance. This idea that the generating or controlling power is connected directly with the self-induction is clearly upset by the fact, shown by Professor Ayrton's experiments, that the self-induction is not sensibly altered by variations of the field strength or position. I need scarcely repeat that the generating or controlling power depends almost entirely on the field strength and position relatively to the armature.

But Mr. Swinburne sticks to the ordinary fallacy, and says—or implies—that such a machine would not act at all either as generator or motor, and reproaches me for attacking existing theories without giving one of my own to take their place. Even that course would have been quite justifiable if I had found the existing theory bad. But I have given a theory. I have said what I thought a perfect generator or motor should be, and have attempted to explain the *rationale* of the action of two such machines when controlling each other. Let me take a case. The armature of my machine has a certain resistance and a certain self-induction. These qualities are unfortunately unavoidable, but I made the machine as good as I possibly could by reducing them both. This was done by the use of a strong and "stiff" field. Need I explain that, if the properties of iron had permitted it, I should have been able so to increase the field as to allow of a proportionate reduction of the resistance and of the self-induction of the armature. And if I could have got an indefinitely strong field I should have reduced the armature resistance and self-induction also indefinitely. Then I should have the "perfect alternators" that I alluded to working as generators or as motors, singly or parallel.

But Mr. Swinburne, bearing out his opening statement, implies that such machines would not work at all.

Then, again, speaking generally, he says: "To make them run parallel commercially needs a large corrective tendency. This can only be got by making the machines so that the maximum current is not at the same time as the maximum E.M.F." This is exactly the opposite of the actually best conditions. Of course they need a large corrective tendency and great stability, as Dr. Fleming says. I urged this strongly in my Paper. Inverting Mr. Swinburne's statement—which really means that the machines must have large self-induction—I say this large corrective tendency can only be got to its fullest extent by making the machines so that the maximum current is at the same time as the maximum E.M.F., at any rate when working on an inductionless circuit. Mr. Swinburne quite correctly interprets the restriction imposed by the conditions he thinks best when he says "that the machines must be made larger to give a given output. They must also be somewhat less efficient." The whole object of the first section of my Paper was to show that such views were both practically and theoretically wrong, and I am surprised that a literal restatement of them should now be put forward.

The best practicable alternator for any and every purpose should have the lowest practicable resistance and self-induction. It will not be larger for a given output or less efficient. It will not have its maximum current at a different time from its maximum E.M.F., and it will exert a large corrective tendency in the most powerful and unhesitating manner, and will maintain synchronism with the least difference of time-phase between any two machines. Such are the views to which I am driven by the logic of facts. On one point I agree with Mr. Swinburne—that if a large corrective margin is required, the internal loss must be large; but even here we do not fully agree. With the old theories the corrective margin was out of all proportion to the effect required to be produced. By the sudden and strong action I obtain by departing as far as possible from the old theories I get this large corrective margin of power by a small margin in the capacity of the machine. It is obviously unwise, however, to attempt to run machines parallel when they require to exert a large controlling power. My experiments showed that they could exert this power; but the driving plant that requires large control is not suitable for parallel working.

Mr. Swinburne's calculations on the efficiency and dimensions of transformers are, I am sure, very interesting; but I scarcely think we are yet in a position to settle these matters entirely on paper. There are so many variables, and there is so little actual knowledge of the laws governing the heating by eddies and by hysteresis in transformers, that it is probably best to rely mainly on experiment for the present. Thus Prof. Ewing says in his letter: "We cannot be sure that the loss by hysteresis is proportional to speed, especially when the speed is "high;" and my experiments on armature cores support this view. Mr. Swinburne, however, is sufficiently sure on this and all the other points to rely upon his calculations for transformers working under widely different conditions. I admire his courage, but advise him to be prepared for disappointments when the transformers are constructed. I cannot at all agree, either, that the eddies in the iron are negligible, in spite of any calculations showing them to be inappreciable. It will be found that my tests bear out very closely the results as regards loss that are known to be obtained in low-period direct-current machines. Those experiments confirm, as regards hysteresis, the results of Ewing and Hopkinson; and as to the eddies it is open to anyone to check them by experiment or by reference to any reliable tests. I would, however, point out that in the celebrated Paper of the Drs. Hopkinson on "Dynamo-Electric Machinery,"* one of the two power readings which are available for this purpose is wrong, the total loss of power being given as less than the calculated hysteresis loss. I have pointed out this discrepancy to Dr. Hopkinson, and find that he is aware of it. It was no doubt an incorrect reading.

Prof. Silvanus Thompson and Prof. Forbes ask for information as to the governing of the engines driving the two alternators in the experiments. Those engines were not governed automatically at all; they were simply controlled by hand. Of course, if they had been well governed automatically, the tests would have been much less severe. As it was, it was left to the engine driver to give each engine as much steam as he thought was necessary. In such a case, if one engine is more powerful than another the power of mutual control is severely tested; if the engines are working under similar conditions then the corrective margin is not required to be large. The utmost strain is put on the arrangement when, as was done in the experiments, steam is entirely shut off one engine.

I trust Prof. Thompson will continue his very interesting experiments on the seat of the back E.M.F. in arcs. The subject requires investigation. The method used will probably yield useful results as regards a comparison between direct and alternate-current arcs. There is one point to which I wish to draw Prof. Thompson's attention, and that is whether there is in an A.C. arc an effect of the opposing E.M.F. in producing a displacement of the current phase. I suppose it may be taken as proved that the arc has an E.M.F. as well as a resistance; and with a rapidly alternating current it seems possible that this may produce a lag, and may act in that respect something like electro-magnetic self-induction. Such an effect may perhaps also be found in A.C. electrolysis. I note Prof. Thomp-

* *Phil. Trans.*, Part I., 1886.

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son's criticism of my statement that in the characteristic the drop is partly due to resistance and partly to self-induction. He does not say that I am wrong. Several effects are produced by the currents—eddy and useful—generated by motion, and it is, I think, allowable to describe the net result on the characteristic as due to self-induction.

I have already referred to Prof. Thompson's expression of doubt as to whether there is time in a half-period for the large mass of iron in the polar horns to become magnetised. He is probably quite right, but I have had no opportunity of settling the point. If there is any effect it will probably be almost a steady one, as pointed out by Sir William Thomson ; that is to say, the iron will not follow the varying impressed magnetising force, but will take up an average state, depending upon the current and the relative position of armature and field.

Prof. Ayrton, in his opening words, appears to ally himself with the views that I have sought to upset ; but I have to thank him for having contributed an account of experiments which, perhaps more than anything I can say, tend to support my contention. He referred to the method of testing transformers that I suggested. That method may be safely used, except with a very inefficient transformer.

As to the curves of temperature, I can only say that I have no reason to doubt the accuracy of the tests, which were most carefully carried out.

Prof. Forbes pointed out that it is wrong to suppose there are only two means of distributing alternate currents. I quite agree with him ; but although I have dwelt at some length on the subject of working parallel, I do not think that method is suitable for all cases. It is a great convenience, and in a properly designed station can always be adopted ; but where, either from the design of the machines or from the character of the engines, a large corrective margin is necessary, then it may be better to work singly, putting such of the mains in parallel on one machine as may be convenient.

If the alternators are suitable for parallel work, then the different mains may be run parallel from a common or omnibus pair of terminal bars, each main being fed through a safety fuse, in order to prevent more than local extinction in case of a short-circuit.

With regard to Mr. Zipernowski's communication, I am sorry he should think the statements I made about working his alternators parallel are erroneous. Those statements are substantially quotations from his own writings. He objects to a passage in my Paper in which I said that his reason for working at the very low periodicity of 42 was to enable him to run the machines parallel. My authority was his own letter, published a few days before my paper.* In this letter—to quote it more fully—he said : "The relatively low number of alternations (5,000 per minute), which we have chosen on principle. . . that we by this means are enabled to couple our dynamos in parallel is not a secondary result, but just the end we were aiming at." Mr. Zipernowski now writes : "We state that we have not reduced the periodicity because of the coupling in parallel."

I must leave these two opposed statements to speak for themselves.

The other statement which Mr. Zipernowski questions is that the magnetic flux in the field ought to be constant, and I am blamed for not giving my reasons for this statement. I did not go into the matter very fully, as it seemed unnecessary ; but when I said that want of constancy "necessarily led to losses in the field, the lamination of which in the Zipernowski machine showing that such losses must be serious," I am sure I sufficiently indicated the nature of the waste which occurs under the conditions referred to.

I am glad to have elicited Mr. Zipernowski's remarks about the Ganz alternate-current motor, and shall look forward to seeing an actual description of that apparatus. The publications on that subject, to which my attention is called, are remarkable for the small amount of definite information they contain. I can learn nothing from them. We are not told anything at all about the form, mode of action, or principle of the machine. There are no doubt good and sufficient reasons for this reticence.

Of Mr. Fricker's contribution I need only say that it is a very clear statement, with which I wholly agree.

* *The Electrician*, May 10th, 1889.

Cape of Good Hope Telegraph Statistics.—The total number of telegraph offices worked by the several administrations of South Africa was, at the close of the year, as under :—Cape of Good Hope Department offices, 130 ; Railway offices, 93—total 223 ; Natal, 51 ; Bechuanaland, 5 ; Orange Free State, 20 ; South African Republic, 20—grand total 319, being an increase of 21 new offices. The result of the alterations made is an increase for 1888 of 29¼ miles new line and 605¼ miles new wire.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July* 20, 1889.

The leading topic of interest in electrical circles in this city during the past week or two has been the investigation that is being conducted by the State as to whether electrical execution is a "cruel and unusual" form of punishment, and whether the murderer now awaiting death should be subjected to it. The inquiry has developed an extraordinary difference of opinion on the subject of whether death by electricity is a sure thing or not, and whether, being sure, it is not open to objection on other grounds. In my last letter I touched on some of the points raised, and may now add that, after all is said and done, the desirability of electrical execution remains as doubtful as ever. It will be remembered that the law was passed without any elaborate or exhaustive inquiry as to the death-dealing nature of electrical currents, and that the main evidence now urged in support of it is that given by the experiments with dogs, conducted at Columbia College by Mr. Harold P. Brown, and subsequently at the Edison Laboratory. Horses and calves, as well as dogs, were submitted to the continuous and the alternating current ; but, of course, although they were killed, the fact that human beings could and would be killed in the same way was purely a matter of inference and conjecture. It cannot be said, moreover, that the experience at the dog-killing experiments was altogether of the most agreeable nature. Commissioner Gibbens, of the Subway Board, who was present, said before the referee this week, "It was one of the most frightful scenes I have ever witnessed. The dogs writhed and squirmed, and gave vent to their agony in howls and piteous wails, until at length exhausted, they fell upon the floor of the cage, worn out with their sufferings." Mr. Gibbens mentioned that his colleague, Mr. Moss, could not stand the sight, but had to retire, as, by the way, did other gentlemen, who were disgusted and sickened with the spectacle. During the present week there has been a great deal said before the referee as to the nature and quality of human resistance, and the effect of the electric current, and with this question—quite a difficult and unsettled one—has been complicated another, namely, how far a man's nerve, courage, or will-power may be able to modify or neutralise the electrical effects. From the way the newspapers are discussing the evidence that has been presented, it is evident that there is a weakening in the sentiment that favours electrical execution, and hence it begins to appear possible that we may be spared from seeing electricity applied to such degrading purposes. It is interesting to note incidentally how the question of the relative safety of the continuous and the alternating current keeps cropping up throughout the inquiry, so that one wonders sometimes as to whether the point at issue is, shall the criminal be killed electrically or shall the alternating current be admitted to general use in the same way as the continuous, arc, and incandescent current?

An interesting system of storage battery development has been brought to the notice of the electrical public this week by the Mutual Electric Manufacturing Company of Brooklyn. This system has been worked out in the "City of Churches" by Mr. E. R. Knowles, who, although a young electrician, is old enough in the art, his first experience dating back to some very interesting associations with Mr. Sawyer, the eccentric genius who figured so prominently at one time as Mr. Edison's active rival in the development of the incandescent lamp. Mr. Knowles' attention has been directed to the problem of utilising arc circuits and apparatus in the daytime. As you are well aware, incandescent stations have now pretty well reached the solution of the difficulty of running throughout the twenty-four hours by the development of power business, hundreds and thousands of motors now being operated on their circuits during the hours of daylight and supplementing the income of the companies in a very satisfactory way. For obvious reasons the introduction of motors on arc circuits has not gone by any means as far, and there are, moreover, a large number of electric plants situated in places where there is no demand for electrical power during the day. This being the case, Mr.

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Knowles has set himself to work to develop a system by means of which the arc-lighting apparatus can be run during the day to charge storage batteries, the lighting capacity of the station being by this means considerably augmented. Over in Brooklyn, Mr. Knowles has already worked out this system practically, and it is understood that an extensive development commercially is contemplated there, as well as in other cities. At the present time, from his charging station Mr. Knowles runs 10 circuits, each machine feeding seven sets of batteries of 30 cells each, or 210 cells for each machine. From the generating station the current is carried to the battery station over arc-light wires placed on poles, the distance being about half a mile in this case, although one of the battery stations projected is more than a mile from the charging station. These battery stations, by the way, may be and are located in any convenient cellar or basement or other place where the rent is so low that it hardly enters into the cost as a factor at all. Another point in this system of combined lighting is, as will be noticed, that the storage batteries and arc lamps are operated over the same circuits. This is accomplished automatically by means of the polarised switch attached to each arc lamp, and to each set of batteries on the same circuit, so that the current passing through in one direction or the other cuts out or cuts in the lamps or the batteries as may be desired. When the switches on the lamps cut the lamps out, those on the batteries cut the batteries in. In practice, it is said, this system works satisfactorily, and even should one of the switches on a lamp fail, the mere fact that the arc lamp was burning in the daytime would attract attention, and cause the lamp to be switched out, as it should be. In connection with this system also, Mr. Knowles has brought out a new form of storage battery, which avoids all pasting or direct application of the active material. The plate consists, practically, of two plates, between which is placed the active material in the form of a third plate, which has been compressed separately in a special mould, and fits tightly between the two walls of metal prepared for it. The electrolyte, as usual, has full access to the active material, but the method is regarded as a pretty good cure for buckling, dropping out, &c. The metal plates are cast, it is stated, of an inoxidisable alloy which contains no mercury.

Among the classes of meters which have not received much attention may be mentioned those of the photographic class. A new instrument of this latter form has just been devised by Mr. G. W. Walker, of this city, a gentleman connected, I believe, with one of the storage battery companies. In this instrument, the current strength at any instant is marked by means of a line traced on a sheet of photographic paper, which travels before a beam of light, whose position is dependent on the current strength of the circuit, so that the needle of the meter may be said to write its record as accurately as a ray of sunshine would. The movement of the needle will, of course, vary in accordance with the number of lamps in use, and as it vibrates and travels back and forth in front of the slot, its movements are photographed immediately upon the travelling band of sensitised paper, which, of course, may be developed at any time, and will show at once what amount of current has been used at any or every moment, the quantity being determined by reference to a graduated scale before which the needle vibrates.

Although the facts may not yet be developed on your side, it would appear, from what is going on here, that the alliance between the Commercial and French Cable Companies has been made closer, news reaching this city from Halifax that the management and operation of the French cable from Sidney to St. Pierre, and thence to France, has been taken over by the Commercial Company, whose energetic manager, Mr. G. G. Ward, has been in Nova Scotia superintending the amalgamation. It is also reported that the two companies have entered into an arrangement with the Canadian Pacific Telegraph Company, whose land lines are being run in order to complete the connection with the cables at Canso. This statement is rounded off by another to the effect that, in order to secure independent connection with the United States, a new cable will be immediately laid between Canso and Boston.

[A contradiction of these rumours will be found in another column.—Ed. *E.*].

There has been a rumour current in Boston this week to the effect that the Western Union Company has applied, or would apply, for an injunction restraining the Bell Company from pushing its long-distance work The newspapers have it that the Western Union Company claims that long-distance telephony will "ruin its business;" but this cannot be the ground of complaint, even if the main assertion were true. It happens that pretty well everybody knows that there is an agreement between the Western Union and the American Bell Telephone Companies to the effect that the latter shall not go into the field of the transmission of general business messages, market quotations, &c., but it would seem that part of the work of the long-distance telephone company must violate and contravene this provision of the articles signed in November, 1879. It would also seem to an outsider that some of the work done by the exchanges over their extra territorial lines, as well as that done over the new long distance lines, must be contrary to the letter of the agreement in question; but it is being done all the same. It is, of course, possible that the American Bell Telephone Company, who are generally astute and well-advised in such matters, are well within their privileges and reservations. It is a little bit difficult to believe that the two great companies, having thus lived in peace for ten years, should now come to loggerheads, and in these days of combination one is more likely to see them come closer together than to find them falling out and getting wider apart. The 20 per cent. commission which the Telephone Company pays to the Western Union amounts, it is true, to about £100,000 a year, but in view of the large earnings from the telephone this is, perhaps, after all, not a high price to have paid for the withdrawal of the Western Union competition in the days when the Bell telephone interests were poor and struggling.

CORRESPONDENCE.

ELECTRICAL DISTRIBUTION BY MEANS OF CONDENSERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with interest your article No. II. in your this week's issue, on the "Distribution of Continuous Current by Means of Condensers," by Dr. Stephen Doubrava; also article No. I., which I had not previously seen. I have been working at this subject off and on since 1886, and have taken out patents in connection with it, and feel that I might add some interesting points.

The title Dr. Doubrava has chosen for his articles is not in strict conformity with the subject matter, seeing that it is an alternating current he distributes by means of condensers and continuous currents.

I cannot follow his explanation for the non-sparking, nor do I think that his curves 3 and 4, correctly illustrate the current charges in the primary and secondary circuits of which he calls his disjunctor. Fig. 3, I think, should be something as follows (Fig. 1). The charge of the condenser commences at *b*, is

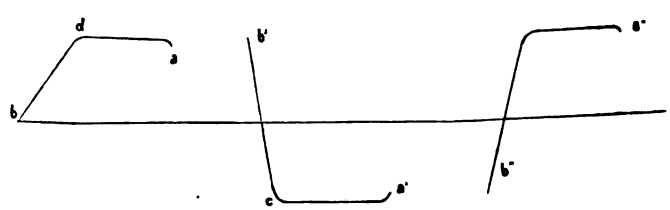

Fig. 1.

fully charged at *d*; is left charged at *a*, with a slight discharge in consequence of the break. Discharge and reversal of current commences at *b'*, is complete at *c*, left charged with opposite current at *a'*, and so on.

From the many experiments I have made, I quite agree with Dr. Doubrava that there should be very little sparking with his apparatus, but it is due to the small quantity of current he

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employs. With current strengths up to about ·25 amperes and pressures of 700 volts, or perhaps higher—this was the limit of my experiments—the sparking is inconsiderable, but larger currents make serious sparking. There seems to be a cohesion in the current, which makes it occupy the most confined space in passing from commutator to brushes, even though the latter be of very large dimensions, which is well illustrated in sparking dynamos. The heat generated by the larger current is also too great for the conduction of the metal to prevent fusion, consequently the metal vapour assists in supporting the spark. The only way to spread the current over the larger surface of the commutator is to subdivide the brush and connect each subdivision through a resistance or other contrivance to the main lead.

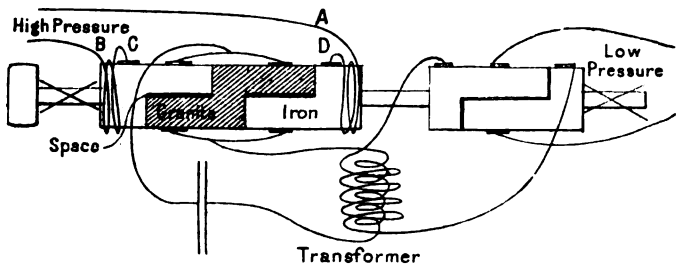

Fig. 2.

My experiments showed that a total break, as proposed by Dr. Doubrava, before the reversal reduced the efficiency, and the only way I found to obtain maximum efficiency was to make a complete reversal without a break.

The above (Fig. 2) is a diagram of the simple form of commutator I ultimately arrived at about two years ago. As will be seen, it is designed for first alternating the continuous current, and then reconverting into a continuous current after it is reduced in pressure. The high-pressure wires were connected to fixed coils of wire surrounding the two commutator blades, which were made of iron, and consequently became magnetic before reaching the commutator brushes *c* and *d*. The effect of the magnetic leads on the current in a spark was to coil it outwards from or inwards towards the axle, according to the direction of current, and to extinguish it with a loud crack, which became very loud if the current were 5 to 8 amperes.

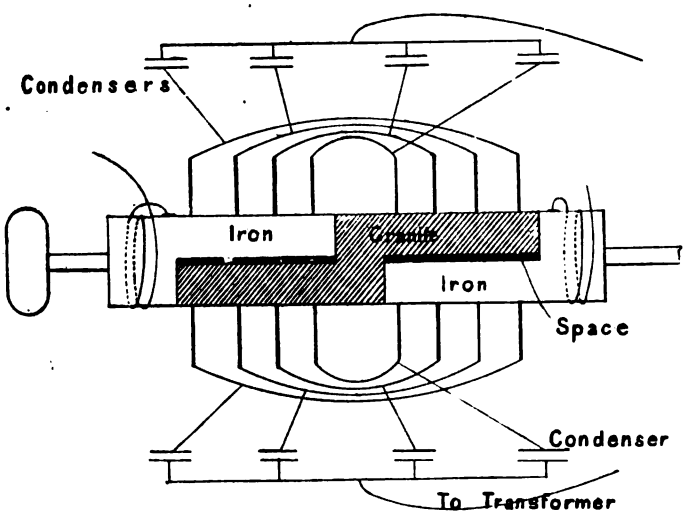

Fig. 3.

To prevent any possibility of a spark connecting the opposite sides of the high-pressure circuit through the commutator, the leaders were separated longitudinally as shown, and four brushes employed, making two pairs, one of which is connected through a condenser to the transformer and back to the other pair, the secondary of the transformer being connected to an ordinary two-way copper commutator mounted on the same axle, so that the two commutators rotated simultaneously. With this magnetised-commutator arrangement it was possible to convert 5 amperes at 700 volts into alternating currents. There is no sparking in the reconversion to a continuous current; the brushes have to be adjusted a little in advance of those on the high-pressure current. The condenser in the circuit reduces the sparking considerably. But in order to make the apparatus work continuously without sparking I made the arrangement shown in Fig. 3 of subdivision with condensers or resistances—preferably, however, condensers, because the current could never increase beyond the quantity found most advantageous and limited by the capacity of the condensers. I still found the magnetic commutators to be an advantage in making the reversal of the current sharp, which was otherwise delayed by the trifling spark momentarily short-circuiting the leads through the brushes.

I never introduced this apparatus to the public, being under the impression that it could not compete with the alternating-current system.

The applications of condensers to the alternate-current transformer system are likely to be very valuable and varied. In the first place, as a safety appliance in the distributing mains instead of a fuse, or even in the branches, a condenser applied for this purpose would prevent the troublesome ignitions and delays in rectifying that fuses often cause. The wires could never get overheated if the condenser is properly proportioned to their section. Even with a dead short circuit across the two mains just beyond the condensers no danger would arise, for the condensers will not permit any more current to pass them than the limit of their capacity, other conditions remaining constant. A less important application is as a substitute for the impedance coil in conjunction with arc lamps, &c., in this application, also it would be a regulation of the current to the lamp.

Should there be any advantage in the system of glow lamps in series, as in the Bernstein system, the condenser is the solution to the problem of perfect regulation of the current to varying numbers of lamps in series, and many circuits may be connected to the one dynamo, and in each the number of lamps may be varied without influencing the others. I have demonstrated this by experiment, twenty-four 100-volt lamps being hung up in series, which were bridged by a loop of wire one after another until the 2,400-volt circuit was short-circuited beyond the condenser, but with no variation in the current perceptible in the lamps.—Yours, &c.,

J. D. F. Andrews.

56, George-square, Glasgow, July 29, 1889.

PARLIAMENTARY INTELLIGENCE.

THE ELECTRIC LIGHTING BILLS BEFORE THE HOUSE OF LORDS.

Last night (Thursday) the House of Lords had before them several Electric Lighting Bills and Orders, when permission was granted to dispense with the Standing Orders to allow them to be read a second time and go before Committee before the close of this Session.

The first was the Metropolitan Electric Supply Bill, for which the Chairman of Committee got the assent of the House to dispense with the Standing Orders and pass the second reading. The Bill will be taken before a Select Committee of the Lords next week, when the Opposition will prolong the hearing probably for a couple of days.

Lord BALFOUR of BURLEIGH then moved the dispensing with Standing Orders, in order that the following Provisional Orders might be read a second time:—Electric Lighting Provisional Orders (No. 1) Bill, Electric Lighting Provisional Orders (No. 2) Bill, Electric Lighting Provisional Orders (No. 3) Bill, Electric Lighting Provisional Orders (No. 4) Bill, and Electric Lighting Provisional Orders (No. 5) Bill. His lordship said that these were the first of the applications under the Act of last year. A great deal of discussion on them had taken place throughout the different local authorities concerned. The first of these Bills concerned several local authorities in the country, and they were, he believed, absolutely unopposed. With regard to the Bill concerning the metropolis, moved by the Chairman of Committees, it was a private Bill. A great deal of discussion had taken place upon these Orders, and so important were the issues involved to the people of the metropolis that the Board of Trade thought it necessary to have a special local inquiry, and that inquiry extended over eighteen days before Major Marindin. A report was afterwards drawn up, and a good deal of negotiation had to be gone through, so much so that the Bill, and practically the Orders, could not be presented for second reading within the time allowed by the Orders of the House. He therefore appealed to their lordships to allow these Orders to be read a second time in order that they might have an opportunity of passing this Session.

This was agreed to, and the Orders were accordingly allowed to be read a second time.

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THE STATE PURCHASE OF THE FRENCH TELEPHONE SYSTEM.

The *Journal Officiel*, of the 27th ult., publishes the text of the Act recently passed by the Chamber of Deputies authorising the Government to acquire the property of the *Société Générale des Telephones*. There are five articles, as follows :—

ARTICLE I.—The Government is authorised to accept in the name of the State the offers which may be made by the towns, public establishments, or syndicates, to deposit at the Treasury, in advance, without interest, the sums necessary for the establishment, maintenance, and working of Urban Telephonic Exchanges, and to devote the profits of each exchange thus created to the re-imbursement of the advance of which it has been the object, without other obligation on the part of the State.

An account will be rendered each year to Parliament of the arrangements in progress under this plan, and of the position of each exchange thus established.

ARTICLE II.—The Government is authorised to effect the purchase, to put into good order, and to develop the telephone exchange belonging to the Société Générale des Telephones, for which purpose an advance of ten million francs will be made by the Treasury.

ARTICLES III., IV., AND V.—[Deal with the manner in which the money is to be paid over by the Treasury, and provide that the sum required in a given year shall be included in the ordinary budget of the year, and with other purely financial matters].

PATENT RECORD.

APPLICATIONS FOR PATENTS.

July 2nd, 1889.

10,678. G. A. NUSSBAUM. London. Improvements in electric transmittors for telephone communications.

10,695. H. H. LAKE. London. Improvements in electric batteries (C. A. Hussey and E. H. Brown, United States).

10,696. H. H. LAKE. London. Improvements in electric batteries (C. A. Hussey and E. H. Brown, United States).

10,699. SIEMENS, BROTHERS, and Co. (Limited). London. Apparatus for automatically regulating the potential in the conductors for two or more sets of electrical lamps (Siemens and Halske, Germany).

10,708. S. C. C. CURRIE. London. Improved automatic electric cut-out

10,709. S. C. C. CURRIE. London. Improvements in insulators for electric batteries.

July 3, 1889.

10,730. H. CHEESMAN and R. F. CHEESMAN. Hartlepool. Improvements in apparatus for electric signalling from or to mining or other cages.

10,744. E. DE PASS. London. An improved process for the manufacture of filaments for electric incandescence or glow lamps (A. de Lodyquine, France).

10,775. A. WELCKER. London. An improved exciting liquid for electric batteries.

10,777. J. ROBINSON. London. Improvements in electric telegraph apparatus to transmit visible pointer indications corresponding to the movements of a transmitting handle.

July 4, 1889.

10,801. H. PIEPER. London. Improvements in electric lamps.

10,814. R. E. KEEN. London. Improvements relating to lanterns for electric lamps and to posts for supporting the same, and for similar purposes.

10,821. C. F. AIRD. London. Improvements in or relating to electrical apparatus, partly for curative purposes.

10,822. G. BUTTON and W. E. WYETH. London. Improved apparatus for extracting gold and silver from their ores by electrical amalgamation.

July 5, 1889.

10,889. E. M. H. ANDREOLI. London. Improvements in the electrolytic production of hydrochlorite of sodium.

July 6, 1889.

10,896. P. WALTERS. London. A new and improved form of support for insulators used for electrical purposes.

10,897. T. PARKER and E. S. G. REES. Wolverhampton. Improvements in the method of distributing electricity from central stations.

10,933. M. VON DOLIVO-DOBROWOLSKY and THE COMPANY ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT. London. Improvements in secondary electric machines.

July 8, 1889.

10,940. F. T. HOLLINS. Derby. Improvements in electrical couplings used in electrically lighting railway trains, and for other purposes.

11,972. A. E. CLEMENTS. London. Improvements in and relating to electric gas lighters.

SPECIFICATIONS PUBLISHED.

1888.

11,570. PIEPER. Electric arc lamps. (Price 8d.)

11,573. HEAD and SAUNDERSON. Electric lamps. (Price 4d.)

11,965. CERPAUX and Others. Anti-induction electric apparatus. (Price 6d.)

12,163. SERRIN. Electric batteries. (Price 11d).

12,283. DE FERRANTI. Railway electric propulsion. (Price 8d.)

12,452. SANDRON. Electric locomotives. (Price 6d.)

13,215. CLARKE (Maiche). Electric batteries. (Price 4d.)

13,987. SAUNDERSON. Electric arc lighting. (Price 6d.)

15,648. CLEVELAND. Electric switches. (Price 8d.)

15,869. HARNESS. Electro-magnetic induction apparatus. (Price 6d.)

18,754. DYMOND (Gassner). Galvanic batteries. (Price 4d.)

10,505. ROUSSEAU. Electric switches. (Price 8d.)

12,332. CAUDERAY. Electric meters. (Price 8d.)

1889.

4,654. CAUDERAY. Electric meters. (Price 11d.)

6,284. PRENTICE. Electric cut-outs. (Price 6d.)

7,597. MEHNER. Dry galvanic cells. (Price 4d.)

7,673. HEAVISIDE. Electric-wire insulators. (Price 6d.)

8,016. NEWTON (Birchall). Electric fire-alarms. (Price 4d.)

8,730. CLARK (Johnson). Printing telegraphs. (Price 8d.)

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

SPECIAL NOTICE.

We are actively proceeding with the 1890 Edition of this Directory and Handbook, and New Names and Corrections to those already in the Book can now be received. Of the 1889 edition there remain unsold only a few copies, which can now be obtained post free to any address in the United Kingdom for 3s. each, or within the Postal Union for 3s. 6d.

Fresh Tables and much additional information will be found in the Handbook Section of the 1890 issue, and every effort is being made to largely extend and improve the Directorial Section.

The new Edition will be published in January next.

In order that the latest insertions and corrections may be made, new names and addresses, and corrections will be received up to about the end of December.

COMPANIES' MEETINGS & REPORTS.

The Direct United States Cable Company (Limited).

The twenty-fourth ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Friday last, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. T. Finnis) read the notice calling the meeting and the minutes of the twenty-third ordinary general meeting, which were confirmed by the present meeting and signed by the Chairman as correct.

The CHAIRMAN : Gentlemen, you have had the report in your hands for some time, and I presume you will take it as read, but before asking you to approve of it I will, as usual, make some remarks upon the report. The revenue for the half-year to 30th June, including £299 for income-tax refunded, and after deducting outpayments, was £39,626, and the working and other expenses, including income-tax, but exclusive of cost of repairs, amounted to £16,676, leaving a balance of £22,950 as the net profit of the half year, making, with £11,642 brought from the previous half-year, a total of £34,592, which has been appropriated as follows :—Interim dividend of 3s. 6d. per share for the quarter to 31st December last, £10,624. 5s. ; interim dividend of 3s. 6d. per share for the quarter to 31st March last, £10,624. 5s.; proposed final dividend of 3s. 6d. per share for the quarter to 30th June last, £10,624. 5s. ; total, £31,872. 15s. ; leaving a balance of £2,719, which it is proposed to carry forward. The revenue for the half-year at the 1s. rate shows an increase of £22,118 as compared with the corresponding period of last year, but the tariff was then only 6d. per word. The half-year to 30th June is always less productive than the six months to 31st December, and it is hoped that the increase noticed in the traffic may continue, when a much better result may not unreasonably be looked for.

The expenses in London, per Abstract "A," are so very nearly the same as in the corresponding period of last year, being £8 less on the whole, that a comparison of details is unnecessary. At the stations the comparison is as follows :—Salaries and wages are £273 higher, owing partly to the additional joint station opened in September last at Boston, and partly to some

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little increase which it has been necessary to make in the pay of the operators, who, for some years past, have had no advancement whatever. Maintenance and renewal of instruments cost £253 extra, principally by reason of the adoption of the "Recorder" instrument at our main-cable stations of Ballinskelligs and Halifax, and from which satisfactory results have been obtained. Travelling expenses, and repairs and renewals to buildings, &c., show a reduction of £35 and £32 respectively. Printing and stationery item is £160 higher, owing to increased consumption of message forms and stationery. This is in one sense satisfactory, showing that the Company has carried over its cable a larger portion of the Atlantic traffic. In the same way the increase of £42 in bank commission is the result of the increase in the receipts to be remitted from abroad. With the exception of the item of £800, for proportion of the expenses connected with the action of the Anglo Company *v.* French Company, which is quite of a special character, the remaining items of expenditure are practically unaltered.

On the 19th April last the main cable was broken on the Green Bank, through the fouling of the cable by a vessel's anchor. Application was immediately made for the use of the Anglo Company's ss. "Minia" to repair, but she was found to be unavailable. A speedy restoration of communication being of the greatest importance, the Telegraph Construction Company's ss. "Britannia" was at once despatched to the position of the break, and restored the cable on the 19th May, at a total cost, including cable used, of £4,474. 1s. 11d. A portion of the cable picked up during this repair was found in excellent condition, after its *sixteen years'* submersion. The reserve fund account, after being credited with interest on the investments and profit on sales of securities, and debited with cost of repairs, now amounts to £242,018. It is not on this occasion proposed to further increase the reserve fund; but it is hoped that in future this account may be regularly increased by transfer out of revenue. The investments continue, as heretofore, to be worth much more than the figure of cost at which they stand in the balance-sheet.

Now, gentlemen, I think these are pretty much the details in connection with our report, and I may mention that probably I have never on any occasion that I have addressed you had less to say than at the present time. I may, however, inform you generally about the state of our cable, as it has cost us a considerable amount during the last 12 months for repairs. I have a letter which we have only received this morning from an eminent electrician, Dr. Muirhead. He says:—"In continuation of my letter of February 28th last, I beg to say that after careful consideration of the tests recently taken of your main cable, and aided by a review of the tests taken during the early years of the cable, I have no hesitation now in giving it as my opinion that your main cable is, electrically speaking, practically as perfect at this date as it ever was. The average insulation of the cable is between 2·8 and 3 megohms at the end of the fifth minute, *i.e.*, over 7,000 megohms per knot—a high degree of insulation for a gutta-percha cable. Moreover, the steady fall in the insulation readings taken at Ballinskelligs Station on July 14th inst. prove to my mind that the dielectric is in a healthy state." I may mention to you that a fault in a submarine cable makes it impossible to work the duplex system, and as you are aware the duplex system practically doubles the working power of a cable. I am happy to say that at the present moment our cable is being worked by the duplex, and consequently it is in a perfect state. I hope it may long continue so. I have just sent for a piece of the cable picked up during the repair the other day on the "Green Bank," which will show you that a cable after being 16 years in the water, if it only finds a comfortable bed to lie upon and is not disturbed in any way, may live to a long life. As you are aware, there was a time when we said that 10 years was something like the average life of a cable, but I think we may with as much confidence say now 20 years, and I would, perhaps, go beyond that, only it is not wise to prophesy. Time passes so quickly that we will allow facts to justify the position rather than prophecy. I have thus shown you that we are perfectly satisfied with the present position of our cables. Now the next question about which I would say a few words is the question of the 1s. tariff. That tariff is earning just double the money that we earned at 6d., and that is a very satisfactory feature indeed; but still it is not earning sufficient money to satisfy the excess of submarine cables now in the Atlantic. If the number of cables there had been simply sufficient to do the work that was required of them, I believe the 1s. tariff would have been a very satisfactory one indeed. I do not see any chance of a change in that tariff, but it is possible that some of the cables may die out. At all events, if the last two cables that were laid had not been laid, I think we should have been in a very satisfactory position. If those two cables which are getting their share of the traffic had not been laid the other cables would be earning a satisfactory dividend at the 1s. rate. I have, therefore, no reason to say that the 1s. tariff does not give a satisfactory dividend, but the misfortune at the present moment is that there are more cables to do the work than are required. However, such has been the growth of telegraphy in my time that I am hopeful that it will continue to grow, and that though we have ten cables at the present moment in the Atlantic while eight could do the work, I believe there will be work for the ten cables if we are patient and trade grows in the future as it has in the past. I do not know that I have very much more to say. The law suit is still going on in France, and there is a great deal of inconsistency connected with it. Still, we must see the end of it, but as the thing is *sub judice* just now, I think it would be unfair to all parties for me to refer to it further than to say that we are persevering with the suit in the hope of arriving at a just solution. The diversion of our cable from Brown's Bank has, I am glad to say, so far proved a success. We were constantly having our cable interrupted by ships' anchors, though not intentionally, and it became a question very often with the fisherman whether he should lose his tackle or break our cable. We have tried to make things pleasant with the fishermen by telling them if they found they had picked up our cable at the loss of their anchors we would compensate them. We have done a little in that way, and it has been very justly and fairly used by the fishermen; but since we have removed our cable to the south of Brown's Bank we have not had one interruption. That is so far satisfactory. The tests of our cable I have spoken of, and Dr. Muirhead has testified that they are excellent. I think with these remarks I will now move the following resolution:—

"*That the report of the Directors, dated 12th July,* 1889, *together with the statement of accounts to 30th June,* 1889, *annexed thereto, be and the same are hereby received and adopted, and that a final dividend be now declared of 3s. 6d. per share, free of income tax, making with the interim dividends already paid a total dividend of 3½ per cent. for the year ended 30th June,* 1889."

I would just add one remark—that is, that this year only shows 10 months' working with the 1s. tariff. There were still two months of the year at the 6d. rate. Had the tariff been at 1s. the whole year the result would have been better. At our meeting six months hence, if I live and have the pleasure of addressing you, I shall be able to give you a fair statement of 16 months' working of the system at the 1s. tariff.

Mr. WM. FORD: I beg to second the motion.

In reply to Mr. HANCOCK,

The CHAIRMAN said that they had been large payers under the joint-purse arrangement to the French Company.

The motion was carried unanimously.

The CHAIRMAN then proposed, and Mr. W.M. FORD seconded, the re-election as a Director of Admiral of the Fleet the Hon. Sir Henry Keppel, G.C.B., D.C.L.

Mr. GUESDON rose to move an amendment to the effect that Admiral Keppel be not re-elected, maintaining that five Directors were sufficient.

Mr. WINDETT WOODS seconded the amendment.

Mr. JACKSON thought the time had not yet arrived for making the alteration proposed.

Mr. BOVILL presumed that the proxies had been issued and stamped at the cost of the Directors.

The CHAIRMAN, in reply, stated that the amendment proposed by Mr. Guesdon was out of order, and maintained that the question of Directors was not merely one of management, but was also one of confidence in the general body of shareholders, and was to give a certain representation to them, and in that representation the shareholders had confidence. As to the proxies, they were paid for by the directors themselves.

The motion was then put and carried with three dissentients.

The CHAIRMAN then proposed the re-election of Admiral R. C. Mayne C.B., M.P.

Mr. MEARA seconded the motion, which, after some further discussion, was declared by the CHAIRMAN to be carried unanimously.

On the motion of Mr. JACKSON, the auditors, Mr. John Griffiths and Mr. Sawyer, were re-elected.

Mr. DEARTH then proposed a vote of thanks to the Chairman and Directors, which was seconded by Mr. HANCOCK, who observed that in bad times Directors were more often deserving of the remuneration they received than in good times, inasmuch as they had greater anxieties to bear and greater work to perform.

The motion was carried unanimously.

The CHAIRMAN, in reply, thanked the meeting on behalf of his colleagues and himself, and said he thought they had done very well in their Company, considering the competition and other difficulties against which they had had to contend.

The proceedings then terminated.

Anglo-American Telegraph Company (Limited).

The ordinary general meeting of the proprietors was held at Winchester House, Old Broad-street, on Tuesday last, the Most Hon. the Marquis of Tweeddale in the chair.

Mr. T. H. WELLS (the Secretary) read the notice convening the meeting and the minutes of the preceding meeting, which were confirmed.

The CHAIRMAN said: Gentlemen, in moving the adoption of the report, which I presume you will take as read, I have, in the first instance, to apologise for the absence of our esteemed Chairman. Lord Monck has been advised by his medical attendant to take a few weeks of complete rest, and I think you will all agree with me in hoping that this will restore him to his usual health. In submitting the report I shall have a more than usually agreeable duty to perform, because although the dividend which we propose to pay is not a large one, and is certainly not sufficient to remunerate those who place their capital in such insecure property as cable property in the Atlantic, it is still by far the best dividend we have been able to pay for several years past—indeed, since 1884. Of course, you know that the increased receipts are due to the increase which took place in the tariff. The tariff has been doubled, and the number of messages has practically remained the same. This is a very satisfactory feature, and is all the more satisfactory because the six months under review are the least productive six months of the year. Already there is an indication of improved receipts since the close of the last half-year, and there is every reason to believe, or at any rate to hope, that by the time we meet you again a still more favourable result will be submitted for your consideration. Gentlemen, it must be satisfactory to you to note that while the receipts have doubled the expenses have remained practically stationary. It is true that if you examine closely the figures under abstracts "B" and "C" you will note that under one or two heads there is an increase, but these increases are exceptional. For instance, under the head of "assurance fund" there is an increase of just £500. This is due to the payment made to the late superintendent of the Duxbury station, who was unable, in consequence of ill-health, to take up his share in that fund when it was started. That

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is a payment which will not, of course, occur again. In the same way, under the "maintenance of land lines" you will observe a slight increase of £600. That increase is due to the removal of our lines in Newfoundland from the roadside to the railway, a very important improvement in economy and efficiency. Our repairing ship, the "Minia," has been actively employed in making certain repairs on the other side of the Atlantic and in the removal of the Duxbury-St. Pierre cable, a cable which, where it was laid before, gave us constant trouble and caused us constant expense. The removal of the cable to its present position will, we trust, be of great benefit to us, and will lead to a considerable economy. The condition of our cables generally is a very important matter, perhaps the most important we have to deal with; and it is a subject of regret that your Directors are not able to say that they are all in a satisfactory condition. The only exception however is that of the Brest cable, which has been, as you know, a source of trouble to us for some years past. The break in that cable in the deep sea, about half way between Brest and St. Pierre is, of course, very much to be regretted. A few years ago such an announcement would have created consternation, or, at any rate, alarm, but it is received now with comparative equanimity. That is due to the skill and experience of those who have to conduct the expeditions for repairing such breakages. You know that we have in our service the captain of the ship "Minia," who is, above all, experienced in such matters. He has been directed to proceed to the spot, and endeavour to effect the repair, and inasmuch as we have something like two months of tolerably fair weather before us, there is reason to hope that before the next meeting we shall be able to report the repair of this fault. If it is not done it will not be from any want of skill or enterprise on the part of those who have the duty of undertaking the repair. I do not think there is anything else in the report to refer to, except the lawsuit which is still going on in France. About that I can add nothing to what is said in the report. The appeal may be expected to be heard in the course of the autumn. You may be aware that the amount decreed to us has not been taken into account in any way, while, on the other hand, the bulk of the expense is already written off, so that whatever comes, should anything come to us under that head, will be entirely to our benefit. Gentlemen, with these observations, I beg to move the acceptance of the report and accounts. The words of the motion are as follows:—

"That the report of the Directors and the accompanying statement of accounts to the 30th June, 1889, submitted to this meeting be and the same are hereby received and adopted."

Sir JAMES ANDERSON seconded the motion.

Mr. THOMAS SMITH had very great pleasure in supporting the adoption of the report, as he thought the shareholders would agree with the Chairman's remark that this was one of the pleasantest meetings they had had for some time past. It must be very satisfactory to observe that the traffic had increased to the extent of £68,000 in the half-year with very little increase in the working expenses. Under the circumstances, he thought they might congratulate the deferred shareholders that they were now within sight of some dividend, especially as the Chairman had stated that the increase in the traffic was still going on. So far as they could tell at present, there was every reason to hope that at the next meeting the accounts would show that the Chairman had spoken accurately in this matter. He wished to ask if the shilling rate, which would come to an end on the 1st September, was likely to be continued? And with regard to the French lawsuit, had the Directors fair hopes that commercial justice would be done to this Company if the late decision were upheld on reference to the higher Courts? The contract was a perfectly free one, and the proportion of the receipts beyond the absolute earnings of their cable by the French Company had been stated at over £250,000. Morally, no doubt, this company had a very large claim upon the French Company; but whether they would get justice remained to be seen. With the present position of the Company they had reason to be gratified, for though the dividend on the Ordinary Stock for the past twelve-months had only been 2½ per cent. and 5 per cent. on the Preference, the prospects were brighter than they had been for some time.

Mr. JACKSON agreed in a sense with what had been said as to the improved position of the Company, but there was one matter upon which the meeting would be glad of information. He did not know whether the statement published on Monday was to be taken as a financial scare, as it came out on the eve of their meeting; but most of them had seen in print a reference to a supposed danger to this Company in the shape of a Canadian cable, which it was said the Canadian Government would guarantee to the extent of £100,000. Personally, he was inclined to regard it as a "bear" announcement rather than anything else. Of course they were aware that such a cable had been talked of for a long time, and there was no doubt that the Canadian Government, like the United States and the French Governments, would like to have a cable of their own to their own shore; but in face of the fact that the year's earnings by this Company produced a dividend of 2½ per cent. only, or considerably below the rate at which the British Government, with Mr. Goschen thrown in, was able to raise money at, and remembering also that the Ordinary Shares of the Direct Company and the French Company stood at about 50 per cent. discount, it was difficult to believe that any body of men would be infatuated enough to subscribe for another competing cable. This company had now reached the end of its twenty-third year of existence, and it was lamentable to know that the starvation rate of interest of the British Funds was all that this Company was able to earn. He did not think this would be an inducement to people to throw another half-million or a million into the Atlantic, for the sake of Canadian patriotism or any other object. There was another question which he had ventilated on previous occasions, and he had the high authority of Sir John Pender in saying that the consideration of the question would be a reasonable one. They had now arrived at maturity, and they were no longer able to put the public under any obligation in the carrying out of this grand invention, which had produced a great revolution in commercial life. He thought, therefore, that the time had come when their managers and those who had the direction of these concerns, should turn their serious attention to see whether they could not possibly develop the traffic. Their most excellent Chairman, Lord Monck, stated on one occasion that it was impossible to create business; but they knew, as men of business, that that was what men were doing every day. Why, in the past two years this Company had increased its business 182 per cent. by meeting their customers in a proper way, and he again suggested whether it would not be possible to introduce the system of deferred messages—messages that would not necessarily have to be delivered within twenty-four hours. They were told that the Post Office would not acknowledge any differential rate of that sort, but that was all nonsense. He thought the matter worthy of consideration. They had at the Board men of the highest integrity, but he was afraid there was not that amount of "go" about them which was necessary to make the concern as prosperous as the shareholders had a right to expect.

The CHAIRMAN: Gentlemen, with reference to the first question, I have to say that the 1s. tariff will be continued from the 1st September. All the companies interested have agreed upon this point. I had rather not dwell upon the question raised with respect to the French suit until the decision has been received by us. Then we shall deal with it in a manner which I am sure will meet with your approval. With regard to the Canadian cable, we know just about as much as gentlemen in the hall who have read the papers. Our information, such as it is, is also based upon newspaper paragraphs. This cable is a very old scheme, I believe. It is impossible to say what people may do with their money, even Governments; but the scheme is not a probable one, and not likely to be carried out I should think. The route which is proposed involves every risk which a cable can be exposed to, including ice and icebergs. That is not likely to meet with the approval of the public certainly, and I doubt extremely whether the Canadian Government will be induced to endow it with £100,000, a year or any other sum. Then, as to the question of developing the traffic, that is one that has interested Mr. Jackson for a long time; but I do not know that I can throw any light upon it further than by saying that what he said has been listened to by our Managing Director, who, perhaps, knows more about the development of traffic than anybody in London, and I am sure whatever is valuable in it will receive his best consideration, and be given effect to as soon as possible.

Sir JOHN SWINBURNE, M.P.: With regard to the renewal fund, what is the meaning of "renewal of artificial lines?"

The CHAIRMAN: That is an expense in connection with the duplex working. It is described as an artificial line because in working duplex you have to provide an artificial line. That is the mode by which the duplex system is carried out in submarine cables, and it is a very expensive process.

Sir J. SWINBURNE: Are the electricians able to say within a mile or two where the cable is broken?

The CHAIRMAN: Yes. The distance of the fault from Brest is about 1,220 miles, and from St. Pierre about 1,460 miles. The depth of the water is from 1,800 to 2,000 fathoms. You will remember that we have already taken up one or two cables at that depth, and if we have fine weather, no doubt we shall be able to deal with this breakage successfully.

Sir J. SWINBURNE: I think it would perhaps be satisfactory to the meeting to know roughly, within £50,000, what is generally considered the cost of laying a cable between here and Canada or Newfoundland. I have heard that it is something like £600,000.

A SHAREHOLDER: How is the annual interest on the investments disposed of? There is nothing in the accounts to show whether it is reinvested or whether it is absorbed in the income.

The CHAIRMAN: It has been put from time immemorial to the renewal fund. Perhaps you were not here this time last year, when this matter was very fully discussed; in fact, a motion was made, which was defeated at that meeting, that the interest on the renewal fund should be paid into the general funds. You will find it in the renewal fund account, "interest, &c., £17,352." That is the amount of interest accrued to the account. I am afraid I cannot enter into the question of the cost of a cable to Canada, which depends on so many things. No doubt the promoters will represent the thing at much less than it would really cost.

The motion was then put to the meeting and carried unanimously.

The CHAIRMAN: Gentlemen, that constitutes the business of this our half-yearly meeting.

Mr. T. SMITH: Gentlemen, I have great pleasure in proposing a vote of thanks to our hon. Chairman and to the Board on the present occasion.

Sir J. SWINBURNE seconded the proposition, which was also adopted.

The CHAIRMAN: I thank you warmly on behalf of myself and my colleagues. I assure you that we lose no opportunity of doing justice to your interests.

The meeting then closed.

Globe Telegraph and Trust Company (Limited).

The sixteenth ordinary general meeting of this Company was held on Tuesday last, at Winchester House, 50, Old Broad-street, SIR JOHN PENDER, K.C.M.G., presiding.

The SECRETARY (Mr. Wm. Payton) read the notice convening the meeting and the minutes of the last general meeting, which were confirmed by the present meeting and signed by the Chairman as correctly entered.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: The report is a full one. It contains a deal of matter in small compass—and I think upon the whole it is very satisfactory. Before I begin to make any remarks upon it, I must refer to the absence of one of our Directors, a gentleman who is

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largely interested in the concern, and who has always taken a lively interest in our affairs. I refer to Sir Daniel Gooch. He has been ill for some little time, but I am very glad to hear from his son, who is also on the Board, that his father is getting better, and I hope, with the fine weather, we shall see him amongst us before very long. When I addressed you last, twelve months ago, I spoke with considerable hope. I referred to the previous year, when I spoke with considerable doubt. Our surroundings were then dark, and the different telegraph companies were passing through a considerable state of excitement in this wise; that the Anglo-American Company, which is one of our largest constituents, was then fighting the question of the sixpenny tariff. Of course, a sixpenny tariff meant very much lower returns for the Globe Company. We had also at Berlin reduced our rates considerably upon other investments of ours, the Eastern Extension and Eastern Companies. I am happy to say to-day that as I predicted at our last meeting in 1888, things have become brighter, and we are able to-day to ask you to accept a dividend on our Ordinary Shares of £4. 12s. 6d. per cent., as against £3. 10s. per cent. last year. This improvement is attributable to the circumstance that the Eastern Telegraph Company, in which we are largely interested, have paid us £6. 7s. 2d. per cent. on our investment with them, while the Eastern Extension Telegraph Company have paid us £6. 6s. 9d. per cent. These two investments, which represent nearly half our total capital, pay us roundly £6. 7s. 6d. per cent. The Preference shareholders, of course, have their guaranteed cumulative dividend of £6 per cent., but it is satisfactory to find, in a return like this, that the yield to the Ordinary shareholder is equivalent to £6. 15s. per cent. on these investments. The point against this advantage is our Anglo holding, and the cost per share there is about 92 per cent. of stock. Last year the return on Anglos only showed £1. 9s. per cent., and the Direct Telegraph Company only showed £3. 10s. 3d. per cent. return; this year the Anglo shows us £2. 2s. 4d. per cent., and the Direct gives us £4. 16s. 7d. per cent. It is a favourable point that the Anglo-American Company is now earning a fair dividend. The shilling tariff has so far satisfied the requirements of the public, and the public accept it as a fair and moderate rate, and we are getting now—or rather, this Company is—just double the amount of money it received when the sixpenny rate was in force. Therefore that means an increased dividend, and we benefit thereby. So on the whole we may take it that the object with which we started, viz., the consolidation of telegraph property, so as practically to guarantee a dividend to the investor by spreading the risk as much as possible over existing telegraph systems running in various directions, has been a success. The main changes that we have made are described in our report. The Imperial German Government has taken over the cables belonging to the German Union of Berlin, and consequently of the German Union Telegraph and Trust Company. The return of capital has been received, and the Directors have very carefully considered its proper application. Our investment of 8,934 Preference Shares of £15 each in the German Union Telegraph Company of Berlin, and of 10,819 Ordinary Shares of the German Union Telegraph and Trust Company, which cost together £249,000, realised £272,500. The profit so made has been apportioned in reduction of the cost of the new investments which are specified in the report. It is satisfactory to know that an analysis of the yield of our investments at the present time indicate, on a fair estimate, that we are getting about £5. 7s. 2d. per cent. Taking off £6 of this for the Preference shareholder, there will remain for the Ordinary shareholder about £4. 14s. per cent. We have purchased some shares of the American Cable Company, and, as the report shows, on an investment of about £48,000 we get a return of £5. 16s. 11d. per cent. This stock is guaranteed by the Western Union Company. This should be a safe investment, although not a home investment. We are anxious that an international character should be given as much as possible to submarine telegraphy, because the cables must rest on many shores. Wherever the flag goes we follow, and the result of it is that we have placed ourselves in a position that wherever there are civilisation and commerce we participate more or less in their growth. The Western Union Company is a very powerful company in America, so powerful that I doubt if there is any company that possesses a greater area or mileage than it, and its guarantee is a very good one. Some people think that there is not a sufficient number of cables in the Atlantic at the present time, and I see by the papers that the laying of another cable to Canada is contemplated. If there was ever anything in the old saying of a fifth wheel to a carriage being very useless and not ornamental in any way, I think it would apply very much to the laying of another cable in the Atlantic. If we had only sufficient cables now in the Atlantic to carry the traffic—if instead of there being ten there were only eight—we should be in a very satisfactory position, but those two additional cables make all the difference. I do not think they benefit the parties who went into the business, and they rather damage those who were in the business already. I hope, however, that experience will rectify this more or less. But, whatever position these cables may occupy, we have to watch them very closely. The purchase of the Direct Spanish Debentures was a good one, because the security was in the hands of a Company who were willing to dispose of their holding as a whole, and we were able to find an opportunity of re-investing some of the German Union money. They return us about £5. 17s. 6d. per cent. We have bought some West Coast of America Shares, which appear in the accounts. This is likely to be an improving investment. The next purchase I may refer to as a change of investment is that of the West African Shares, of which we have bought 3,145 £10 shares. As this Company has been brought into the circle which encloses the continent of Africa we thought it right to take an interest in it; the prospects in the future of this Company seem to be good. It is of interest to know that our own stock at the market prices of to-day, say £15, £8½, and £23½, show a higher value over the market price of the securities which we possess by something like 10 per cent. This of itself shows the utility of this Trust, and the stability it has given to telegraph property. We have now been in existence 16 years, and while we have always been able to pay our Preference dividend, the average dividend paid on the Ordinary Shares from the beginning has been £4. 6s. 4d. per cent. We are now paying £4. 12s. 6d. per cent., and I hope it may have still an upward tendency. This shows an average dividend, taking Preference and Ordinary Shares together, of £5. 6s. 3d. Altogether, looking at the matter all round—at the investments—I doubt if they have been in a more satisfactory state than at the present time. The one shilling tariff of the Anglo-American Company has only been in existence ten months, and by the time I meet you again we shall have had a full trial of that rate. That ought to add something to our dividend. I have now given you a general detail of what is being done. Our Company is actually one of the pioneers of those Trust companies which have been formed of late years (and many of them within this year, I may say) to break up dividends and divide them. Our Company was established years ago on the principle of Preferred and Deferred Shares, and we stand in a very fair position at the present time. The 6 per cent. has always been regularly paid. The Deferred dividend is a fluctuating element. Still, all the progress that takes place in submarine telegraphy in the future will benefit the Deferred Shares, as the increased dividends we receive must be applicable to the dividend we pay on those shares. Looking at the increased value of our investments, I look forward with hope that the prosperity which is now surrounding submarine cables will continue, and that the Deferred Shares of this Company will take up the position they are entitled to take. With all the various companies I have spoken of we have great influence, because we are large shareholders in these undertakings, and what we desire above all things is to see the companies in which we are interested prosperous, because if they are the Globe Company is naturally prosperous. With these few remarks I now move—

"*That the report and accounts for the year ended July 18th, 1889, submitted to this meeting be and they are hereby received and adopted, and that a dividend be now declared payable on and after this date of 3s. per share on the Preference Shares, less income-tax, and of 4s. on the Ordinary Shares, income-tax having been already deducted, making, with previous payments, a total dividend for the year of 6 per cent. on the Preference Shares, less income-tax, and of 4⅝ per cent. on the Ordinary Shares.*"

The MARQUIS OF TWEEDDALE seconded the motion.

The resolution was carried unanimously, there being no discussion upon it.

The MARQUIS OF TWEEDDALE then proposed the re-election of Sir John Pender to his seat at the Board.

Mr. HENRY D. GOOCH seconded the motion, which was carried unanimously.

The CHAIRMAN, in replying for this renewed mark of confidence on the part of the shareholders, said that the Company was in itself a rather powerful Company, having the power to do a great deal of good or a great deal of harm. Their affairs had to be managed with great discretion, and he was very pleased by this renewal of the confidence of the shareholders that they did not disapprove of the way in which the Board had managed the Company so far as it had gone. He concluded by moving the re-election of Sir James Anderson to his seat at the Board, remarking that that gentleman was a most thorough colleague, who was always found at the post of duty.

Mr. WM. FORD seconded the motion, which was carried *nem. con.*

Sir JAMES ANDERSON having briefly returned thanks,

Mr. STEARNS proposed

"*That Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths and Co.), and Mr. Wm. Griffith, B.A., Barrister-at-Law, be and they are hereby re-elected auditors of the Company.*"

Mr. ANDERSON seconded the motion, which was carried unanimously.

Mr. GRIFFITH, in returning thanks, said that the auditors had verified the accounts, inspected the securities, and found everything as satisfactory as it ought to be. He then proposed a vote of thanks to the Chairman and Directors, paying a warm tribute to each and all of the members of the Board for the ability, experience, and technical knowledge which they brought to bear on the conduct of the Company's business.

Mr. JOSEPH KING seconded the motion, which was carried unanimously.

The CHAIRMAN: Gentlemen, in returning thanks on behalf of my colleagues and myself I think Mr. Griffith has very fairly pointed out that we have a rather remarkable Board—a Board who are able to take a very broad view of the varied concerns in which we are interested. I believe that that view is generally taken with a great deal of consideration and discretion. In my opening remarks perhaps I did not sufficiently emphasise the most important addition to submarine enterprise which has been made recently. I allude to the West African system of submarine telegraphy. Probably that is the completion of one of the most remarkable among the many remarkable things which have been done in connection with submarine telegraphy. We have completely surrounded Africa, and you will see that we have not been backward in seeing that that was going to be a very large and very profitable investment eventually, because if you look at the report you will find that we have already made a very considerable investment in that Company, believing as we do that it possesses a very great future. Its great future is this—that it reaches the Cape, and the Cape, I believe, is the country of the future. All the work of our philanthropists and enterprising men seems to be concentrated upon Africa at the present time, and I believe England has got probably the country most valuable for mercantile, commercial, and, above all, mining purposes, and as long as they continue to flourish it is wonderful how much telegraphy flourishes along with them. Our investment is already made there. We have sown the seed, and I believe we shall eventually reap a very good harvest. With these remarks, I beg to thank

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you for the confidence you have shown in us. My colleagues and myself work as one man, and if concentration makes power, we are a very powerful Board indeed.—The proceedings then terminated.

The Edison and Swan United Electric Light Company (Limited).

The annual general meeting of the shareholders in this Company was held on Tuesday last at the City Terminus Hotel, Cannon-street, Mr. James Staats Forbes presiding.

The SECRETARY (Major S. Flood-Page) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: In accordance with my usual practice, I shall proceed to make a few remarks upon the report and accounts, to give such elucidations of the figures as you may desire, and then to propose certain resolutions. I had better go at once into the figures, and afterwards into general subjects connected with the Company. The balance-sheet I shall shortly deal with first. The debtor side shows the state of capital account, which is unaltered during the year. There have been no additions to capital during that period. The account is set forth in as simple a form as possible, and you can easily see how it is made up. Putting the different sums together of fully paid and partially paid shares the "A" capital comes to £353,478. That you know is a particular capital, which, being unencumbered with any prior charges, comes in first for the fruits of the undertaking. After that there are so many "B" shares amounting to £117,820, being the shares, in fact, which were allotted to Mr. Edison and his friends, and which stand in the position of Deferred Shares, and are not entitled to any dividend until the "A" shares have received the full amount of 7 per cent. cumulative dividend from the commencement of the Company. Sundry credit balances are £4,711, being money for which we are indebted to outsiders, and about that item I have merely to say that it is more favourable than it was last year, when it stood at £10,214. That is to say, that we have managed to bring down our indebtedness outside capital to £4,711. The last item is not the least satisfactory one—profit and loss as per appropriation account, £44,037; that is as against last year in round numbers £25,000. On the other side of the account we show what we have to represent that money. There you see that the cost of patents, goodwill, preliminary outlay, loss on working as per last balance-sheet, amount to £274,991. During the year we have spent under this head £13,999 in addition, but we have realised in diminution of that sum, by sale of plant and other sums which we have to receive, £12,560. Then we thought it a prudent thing to disembarrass the amount of £12,000, which we held in the Manchester Company, under an agreement by which they were licensed by, and had certain advantages from, our Company. These shares, amounting to £12,000, we transposed. They do not disappear, but come into the accounts further down. The further reduction of losses on realisation of sundry installations, taken over at the date of the amalgamation, comes in among capital outlays. The Directors have, of course, from time to time explained the nature of this business when it was taken over. It had a number of very good elements, but it had some very bad ones, and our business from year to year has been to eliminate the bad from the good, and to charge to the working of the undertaking as opportunity offered the losses which were made in getting rid of these bad bargains. I am glad to say that I think we have, so far as we know, come to the very end of that unfavourable side of our business, and I should just like you to realise the effect of that. The asset cost of patents, goodwill, preliminary outlay, &c., must be looked upon in the sense of not being a concrete tangible thing, such as chairs, tables, or anything of that sort, and, therefore, it is different from the items you find set out below, which are concrete things, such as the Manchester Edison-Swan Company's shares, investments, and freehold property. They are something having a current and immediate value. The other item has a value no doubt. It has the value represented by the dividend which from time to time you will be able to pay on your capital from the going concern in which you embarked. But it strikes me as being a satisfactory thing that the result of our working for the year has enabled us to reduce what I may call the dead asset, thereby very considerably adding to the living asset. If you cast your eye over the items you will find that the cost of patents as per last balance-sheet was £274,991 (that is how we began); whereas if you look further down the page you will find it is reduced to £235,614—in fact £39,377 less than they were. As a matter of fact, I suppose that they are well worth what they stand for in the balance-sheet, but if they were well worth £274,000 it is much better that that amount should be in figures £39,000 less, because while their real value does not diminish, there is the other hypothesis, that they are not worth so much, and we are so much better off. Then, coming to what I call a living asset, the Manchester Edison-Swan Company's shares—£12,000—I have to observe that that is not a particularly productive asset at the present moment, because it stands in the same category as the shares in this Company paid to Mr. Edison, £117,000. It is deferred to the capital provided by the Manchester Company for establishing their business. But some day one may hope that in this electric lighting business, which is showing great signs of expansion, that which was not a profitable asset may in the future become a very profitable one. I think our own shares are a very good illustration of that. In two or three years the position has so changed that we are able to meet under circumstances altogether different and much more gratifying to both Directors and shareholders than on any former occasion. Investments amount to £27,500. They are for good money representing well-invested capital. Freehold property stands at £27,991. That covers the possession of the land and the factory where we are now manufacturing our lamps at Ponder's End, and in London the Green-street site, and also a remnant of property that we have at Newcastle. Taking these three together I think we may say with confidence that they represent £27,991, which is a great deal less than their actual value. Plant and stock amount to £40,406. Of course, our factories are fitted up with plant and stock, and we have from half-year to half-year a great deal of tangible concrete value in that form. Of course the value of such things depends upon their being part of a going concern. If we had to anticipate the possibility of the business stopping, and these appliances being thrown out of gear, they might not be worth 20s. in the £1; but as parts of a going concern, producing profit, they are certainly not over-estimated at that price. Office furniture is so small that it almost wholly disappears. It is being written down from time to time, and I daresay the time is not distant when we shall have redeemed all our furniture. Debtors are £29,221, but we believe they are all good debts. Cash at bankers and in hand is £29,206. Well, now, in like manner, compared with the corresponding values of the money last year, that item has increased. It stood at £125,800 last year, whereas it is now £166,610, or in round numbers £41,000 to the good, and I think we may congratulate ourselves upon the fact that we have a credit balance-sheet highly satisfactory, and indeed representing the full value of the debits on the opposite page—that is to say, the full value of the capital invested. We now come to profit and loss account—that, in fact, is the trade account. There, again, I am happy to congratulate you upon the realisation of what has been predicted from time to time, that this business of ours only wanted time to develop and to develop rapidly. It has grown with some rapidity during the last year. You remember that in the preceding twelve months we showed the not inconsiderable advantage of having realised about £25,000. For reasons which were explained at the time, and which the judgment of the proprietors then, as I daresay it will now, commended, that amount was not distributed, but was kept in reserve. As compared with that figure, the profit this year is much larger. I had better take you through the items, however. You will see from the debit side of the account that we brought forward stock on hand (and that stock means lamps and materials connected with the manufacture of lamps as distinguished from the value of plant in the factory itself) to the amount of £19,590. During the year, in order to create the article we sell, we have had to spend in wages, purchases, cost of installations, &c., £62,529; salaries, Directors' fees, office expenses, insurance and general charges are £8,562; and then there is a small item of a special character, £523, which will disappear from the accounts in future, Mr. Swan's particular bargain with the Company having terminated. Depreciation on plant is £1,394. Reserve for Manchester Edison-Swan Company is a small amount in the nature of damages we received. Income tax is £257. Then, on the other side of the account, by sale of lamps, fittings and charges for work done, we received £111,715, for interest on the several investments £1,047, Messrs. Davidson and others £2,140, which was rather in the nature of an accidental item, being damages as the result of litigation with them for having infringed our lamp, they having had to pay the penalty. Stock on June 30th stood at £25,985. We began the year with a stock valued at £19,500, and we end with one valued at £25,935, or in round numbers £6,000 more. That stock must in the nature of the case increase from year to year because it bears a proportionate relation to the volume of our business. When you have a large business you must have a large number of lamps on hand to meet the extended area. When you have a smaller business the stock must be somewhat less. You will see that the value of the business this year is £112,763. Last year it was £88,404. Therefore, our sales increased by £24,000, and the increase in the stock is in about the same proportion. Now we come to the expenses, and there is rather a gratifying feature about them. We have often said here that the business was of a character which involves, compared with some other businesses, a very large sum for fixed charges. Whether you produce 100,000, 200,000, or 300,000 lamps there are of necessity certain fixed charges, such as rates and interest, and the outlays on the factories and our official salaries, and things of that sort, all charges of a general kind, as distinguished from charges for wages or material, which are incidental to the manufacture itself. Now, looking at that it is so far satisfactory, that whereas the cost of our business in 1888 was £70,000, in 1889 it is £73,365, so that you have an increased sale amounting to £24,000 at an increased cost of £3,500, and the result of these two things operating together is to increase the balance from £25,000 odd last year to £47,729 this year. That is the result of the year's working. We shall now come presently to the appropriation of the balance, having brought you down to the fact that the balance-sheet is more satisfactory, in the sense of the living asset being beyond the dead asset figure, and the profit and loss account, showing the result of a large increase of profit legitimately made, and we shall take you to the various paragraphs of the report. Only I have, in telling you that, pretty nearly exhausted the whole of No. 2 paragraph. It shows that there is a credit balance of £47,729 on the working of the year. It deals also with the £25,123 profit on working brought forward from last year, which we did not divide for reasons that I have explained; and then it describes how the Directors deal with the total of £72,852. We were from the first face to face with the practical question of the distribution of dividend, and the distribution of dividend in these joint stock companies is one not without its thorny places, so far as the responsibility of the Directors go. They are, like other trustees, obliged to consider what the ultimate consequence of their action will be in dealing with a trust, and there has been so much litigation—so much partially-made law—as to what is capital and what is profit that we have been obliged to be very particular indeed in the consideration of these matters from year to year. Of course it is more or less an abstract question. There is really no settled law upon these subjects by which directors can stand hard and fast. They are in the unfortunate position of having to determine in the absence of specific law what they ought to do in justice to the shareholders, and with due regard to their own protection as trustees. We have thought it judicious to write down everything in the nature of a loss which has accrued since this business was initiated. We went into it with our eyes open. We knew that there were some bad bargains, and the sooner

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we got out of them the better. We did get out of them, from time to time having written down considerable sums for those losses. In 1884-5-6 we had, indeed, a certain amount of those losses, and in the balance sheets they were dealt with by letting them remain in capital account as part of the goodwill. The words are very explicit, "By cost of patents, goodwill, preliminary outlay, loss on working," &c. Well now, we have eliminated every one of these things, and by appropriating £28,815. 14s. 2d.—which is, as far as we can ascertain at present, the last item which is likely to trouble you under the head of losses—in conformity with the absolute discretion invested in the Board under clause 89 of the Articles of Association, we think we have done what is exceedingly prudent, as men of business, and something which I am sure, if you were as intimate as we are with the circumstances, your judgment would commend. We have done it this time, because we feel we can afford to do it. After that deduction, which is one of the items diminishing your dead asset to that extent, we have still a very large sum of money for distribution; and we have, under Clause 89 of the Articles of Association, created a reserve of £4,595, and the Directors recommend the appropriation for dividend, in accordance with clause 87 of the Articles of Association, of 7 per cent. upon the amount paid up on the "A" Shares in respect of the year ending 30th June, 1889; so that the outcome of the working for the year is this, that for the first time in the history of the Company the profits of the business have justified the full dividend for the year on the "A" Shares. But that dividend is not a dividend resting on the profit of a particular year. It is a cumulative dividend. Therefore, where in any year the profits are not sufficient to pay 7 per cent. the balance becomes a charge on the extra profits of future years, and if you are familiar with the accounts in the balance-sheet we have continually brought to the knowledge of the proprietors that the Deferred "B" Shares are entitled to a quarter of the profits after 7 per cent. is paid on the "A" Shares. The preferential accumulative dividend amounts to £121,374. 3s. 10d., so that the appropriation of profit for this year and in future years will be 7 per cent., which is all you can divide upon the "A" Shares; but such a further sum as the money will run to in order to put into your pockets accumulations in respect to previous years. Having exhausted the purse so far as the 7 per cent. required it, there was still enough left to wipe out some of the arrears of the accumulations, and upon that we propose to take a further 3 per cent. on account of the arrears of preferential dividend in respect of the "A" Shares, so that the dividend is in fact 10 per cent. What one would like to impress upon the proprietors is that it is 10 per cent., not in virtue of any right of the proprietors to receive 10 per cent. in a particular year—they are only entitled to receive 7 per cent.—but in virtue of the 3 per cent. coming back into their pockets in respect of the money which might have done, but did not find its way into those pockets a little earlier. It is in fact paying up old scores. I must qualify what I have said by this. When these arrears are wiped out, as it is supposed they will be, and towards which we have given a modest contribution this year, if the business progresses in anything like the ratio it progressed last year, that 3 per cent. will be made somewhat larger. The 7 per cent. cannot increase; the 3 per cent. will, assuming the work of the Company to go on progressing for the next few years. Then the "A" Shares stand in this position. Up to 7 per cent. they take the first fruits, and over 7 per cent. they participate *pro rata* with the £117,000 "B" Shares. I have now exhausted that. When I come to the appropriation account I shall have to show you that the appropriation of 7 per cent. and the 3 per cent. on account of arrears does not quite exhaust the purse. Paragraph 3 is more general, and turns upon the position and future of the Company. I suppose this is an occasion when, without being hilarious, we, the Directors and shareholders, may really congratulate ourselves upon the improved position of the Company. Everybody knows that in the few years that have elapsed since the initiation of this Company we have gone through a great many troubles. We have had litigation, we have had to defend patents, we had many people ready to deprive us of the advantages of our venture, if they could do it, and I dare say the shareholders have very little idea of the amount of serious anxiety and responsibility which the position of those questions threw upon the shoulders of the Directors, because although you have the most eminent counsel advocating for you, though you have the most eminent scientific witnesses giving evidence for you, there are always two sides to a question, and great interest being at stake involve great efforts on both sides. The antagonistic side fight hard for a possible victory. The nature of these things is very much this: Learned counsel use the best arguments, eminent scientific witnesses give the best evidence they can for you, and then the other people tell their story. Sir Horace Davey makes a very good reply to Sir Richard Webster, and some other scientific gentleman makes a very good reply to Sir Frederick Bramwell, and after those replies are heard and that evidence is given—the prosecuting side—the plaintiff, as it were—does not feel so very sanguine. The learned counsel begin to vacillate a little in their feelings about matters, and they come to the Directors, who are watching the proceedings, and they say, "Well, we think it is all right, but it might not be." Now, then, what are you going to do? I assure you, having gone through with our excellent Deputy Chairman, Mr. Leyland, Viscount Anson, and the other Directors, we had a *mauvais quartier d'heure* it was not easy to decide. When we are so confident in our right we feel inclined to go on and win, and not listen to a compromise, for people are apt to say no compromise can be so advantageous as to succeed when you are in the right. That is the sort of thing we have had to do two or three times over. Happily it is all gone. There has been a great deal of litigation, but, at all events, reasonably speaking, we believe that the patents of this Company are beyond attack. It was really in respect of the Woodhouse and Rawson Company that we felt for the first time—and certainly with greater intensity than I ever remember having experienced—the feelings I have described of the sense of responsibility of deciding what to do; but since then the same old friend with a new face started up in the shape of the Brush action. Then there were fluctuating doubts that we had to decide, and the result of our decision was that we have got all we went for. If we had not got all we went for, and they had got all they went for, your position would have been entirely different from what it is. We doubt whether there would have been any dividend to pay. Certainly if the decisions that we arrived at had not been arrived at it would not have been, as business men, prudent on our part to pay any dividend. Now we pay it without the slightest compunction or fear that to do so is in the least degree unsafe. I have anticipated paragraph 4. That shows that all this business over the Woodhouse and Rawson suit cropped up again, and Mr. Justice Kay gave a decision against us, but in favour of the Cheesborough patents. He declared the Edison patent to be invalid. That was a dreadful thing to contemplate, and we determined to appeal, and we were happy enough first of all, by dint of the goodness of our case, and not less by the splendid energy and ability of the learned gentlemen who conducted it, and especially of the Attorney-General, we were successful in a strong Court of Appeal in the most conspicuous way in getting the decision of Mr. Justice Kay reversed. Well, of course, nobody likes to be beaten, and the Brush Company, although they have got an American taint about them, did not like to be beaten, and so they having reserved the right to appeal to the House of Lords, we were face to face again with these things that I have described. This is a capital judgment, but there is the House of Lords, and I know something about the House of Lords, but there was at one time the possibility of having our position greatly damaged by that appeal. Then wise counsel prevailed, and we, having established our rights, were not particularly anxious to use them either harshly or ungenerously to the Brush Company; therefore we did not go in for exacting the uttermost farthing. We made something in the nature of a compromise of a highly satisfactory kind to us, and, as I understand, the Brush Company are greatly pleased with it; so all I can say is, that we are pleased all round. They have ceased to make lamps. They have handed over to us the benefits from certain patents of theirs—I daresay they are worth something—and they pay the taxed costs of litigation, and I think that is a very good solution for us, and I think it is a very good solution for them, so we shall have no more litigation of that kind. That I believe is the end of the chapter, as far as the report goes. Now, what I should like to do is to impress upon our absent friends the fact—because I cannot disassociate from the company any parts of it—but for the forbearance and confidence of the shareholders it would have been impossible for the Board to feel that confidence in their litigation which has carried them through it. Therefore we are all being rewarded. You are being rewarded for your forbearance to and confidence in us, and we are being rewarded because our judgment, hard work, and anxiety have resulted in your undertaking being put on perfectly safe ground, and on the fair way to be made a very profitable enterprise. I take this opportunity of thanking our able legal advisers and our official staff, not least our friend the Major, for the great assistance they have given. There is one item which is quite new, and as to which my colleagues and myself are most anxious that there should be no mistake on the part of the proprietors. I am sure we should be, notwithstanding any idea that we have formed of our services, exceedingly uncomfortable if the proprietors were induced to accept this report without a thorough understanding of what the position of the Directors in regard to their remuneration means. The Directors' remuneration is fixed in accordance with clause 66 of the Articles of Association. This Company is formed on a basis very common—I was going to say almost uniform—among joint stock enterprises so that the Directors are partners in the profits. They receive remuneration more or less for their services, and they take it for better or worse until the profits themselves exceed a certain figure. When they do the Directors participate proportionately in the increase. As this is the first time this question has been raised I think it is only right that you should understand it, because humanity is a curious compound, and I myself have seen a great deal of these things, and I find that the best plan is to be perfectly outspoken and to have a perfect understanding with your friends and employers. The conditions upon which the Board serve the Company are set forth in the Articles of Association. Having read the clause alluded to, he continued: That is the contract as between the Board and the shareholders. I do not know what the feelings of the shareholders may be, but looking at the fact that we have had some very hard work (and I think I am entitled to speak with some authority on such matters) in proportion to the visible funds of the Company—for we have worked out of all proportion to that, and have had greater anxiety responsibility, and labour than in some great financial and great railway companies—we think we are fairly entitled to that money. It is ours, of course, by right, but I think we should not be inclined to press, right against the sense of our own judgment, that it was right or against the sense expressed by the proprietors if in their view they thought it was not right. During the early days of the Company we felt that we ought to forego some remuneration, but after the vast amount of labour that we have had we think we are entitled to it, because the Company is now in a position to pay it. We have, therefore, no hesitation in claiming it, that claim being thoroughly understood by the proprietors, and I hope not only understood but greeted with readiness. He concluded by formally moving the adoption of the report and accounts.

The DEPUTY-CHAIRMAN (Mr. F. R. Leyland), in seconding the resolution, said he would like to add a few words to what the Chairman had said—and said so well—by way of congratulating the shareholders on the position of affairs laid before them. He thought that if any gentlemen were to refer to the first accounts that were laid before the shareholders, and compare it with the statement of affairs now, he thought it would be readily admitted that there was good ground for congratulation. They started in 1884 with the management expenses at £26,350, and they had succeeded in bringing them down to £8,562. They started with a loss of £28,814 in the year, which they had converted into a profit of £47,719 in the year. These were facts for which the Directors

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might fairly claim credit, and he had no doubt it would be given to them by the shareholders. They had had great difficulties to strive against. In addition to bringing down the expenses they had had their titles to fight, which had been a troublesome matter. As to their arrangement with the Brush Company, they had not given up anything great or material. The only thing that they had given up was their right to sue them for the damages we had incurred by the infringement. He thought they were acting wisely in foregoing that claim. On the other hand, the Brush Company had given way entirely. They had paid their taxed costs, agreed at a sum of £11,500. Then they had raised an action against us for some alleged infringement of patent that they held. They did not think there was much in that, but they thought it a very desirable thing to have no more litigation, and they agreed to take licenses of all the patents of any description held by the Brush Company, paying a royalty of ¼d. on the lamps made, a further stipulation being that the royalty in one year should not exceed £375.

Sir JOHN LUBBOCK, Bart., M.P., rose for the purpose of congratulating the Board on the very satisfactory report and balance-sheet which they had been able to present. He thought he was the only one present who had acted as a Director on the other companies taken over by the present Company, and consequently in that capacity he was in a position to form a right impression as to the difficulties which the Board had had to contend against and he wished to thank the Chairman, Deputy-Chairman and Directors and the Manager for the very able manner in which those difficulties had been overcome. As a shareholder in the Company, he might say that he not only agreed that the Directors should receive all that they were entitled to, but he believed it would be to the interest of all in the future that the Directors should have an interest of the kind in common with the shareholders, seeing that it was of a very moderate character for the great amount of work that they had had to perform.

The CHAIRMAN, in answer to Mr. Philip, said that the Swan Company were shareholders in this Company to a very considerable extent. Of course they would get in their capacity of a company their dividend in bulk. The shares in the Swan Company were held in bulk at the present moment, and the dividend would go into the balance-sheet of the Swan Company, and so would find its way through that channel into the pockets of the proprietors in due proportion.

The resolution was then carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. LEYLAND, the dividends recommended of 7 per cent. on the amount paid up on the "A" Shares in respect of the year ending 30th June, 1889, and of 3 per cent. further on account of the arrears of preferential dividend on the "A" Shares in respect of the year ending June 30th, 1889, were formally declared.

The CHAIRMAN then moved, and Mr. LEYLAND seconded, the re-election of Viscount Anson and Mr. Ernest Villiers to their seats at the Board.

The motion was carried unanimously.

Mr. SANDEMAN next proposed, and a SHAREHOLDER seconded, the re-appointment of the auditors, Messrs. Welton, Jones and Co., which was also agreed to *nem. con.*

The CHAIRMAN spoke in warm terms of the assistance Mr. Welton had rendered the Company.

The CHAIRMAN here took occasion to refer to the forthcoming visit of Mr. Edison to Europe, and expressed a hope that the great inventor might see his way to visit London, when the Company might have the honour, which the whole of the civilised world owed to him, of affording him some recognition of their appreciation of his merits and great inventions, more especially as they were associated with him in carrying out those inventions.

On the motion of Mr. WILSON, seconded by a SHAREHOLDER, a hearty vote of thanks was passed to the Chairman and Directors, which brought the proceedings to a close.

The Cuba Submarine Telegraph Company (Limited).

Report of the Directors for the half-year ended 30th June, 1889, to be presented at the thirty-sixth ordinary general meeting of shareholders to be held on the 7th day of August, 1889:—

1. The Directors beg to submit, duly audited, the balance-sheet and accounts for the half-year ended 30th June last.

2. From these it will be seen that the gross receipts (including the balance brought from last account) amount to £24,980. 1s. 11d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs) to £8,434. 17s. 2d., leaving a sum of £16,545. 4s. 9d. to the credit of revenue account.

3. Of this the sum of £6,000 has been added to the reserve fund, increasing that fund to £90,000.

4. The dividend on the Preference Shares will absorb £3,000, and leave £7,545. 4s. 9d., out of which the Directors recommend the payment of a dividend on the Ordinary Shares at the rate of 9 per cent. per annum, free of income-tax, the balance, £345. 4s. 9d., being carried forward to the current half-year's account.

5. The Batabano-Cienfuegos Cable, mentioned in the last report as then showing sign of breaking down, was repaired by the Company's engineer, Mr. Keith, in May, several faults having been cut out, and wasted parts replaced by new cable to the extent of seven knots. Unfortunately, however, this cable ceased to work on the 13th inst., and Mr. Keith has again proceeded to its repair; meanwhile the Company has arranged for the use of the Government land lines as before. This section, which is a portion of the original 1870 cable, is in some places in a worn-out condition, and its continuing to work without frequent repair can hardly be expected. The Directors have therefore decided to have it duplicated, and this will accordingly be done without loss of time.

6. The other cables continue in good working order.

7. In consequence of representations made by connecting companies, the question of a reduction of this Company's rate for transit messages has for some time occupied the attention of the Board, and as the recent establishment of cables by a French company, connecting Hayti, Curacao, and Venezuela with the Island of Cuba, will, it is hoped, result in a permanent addition to this Company's traffic, the Directors have thought the present a favourable opportunity for lowering its rate with the least prejudice to the receipts of the Company. The reduction, which came into force on the 1st inst, will entail some loss of revenue, but this, it is anticipated, will in course of time be counteracted by the expansion of the Company's business. One or two unimportant modifications of the local rates have also been made.

8. The Director who retires from the Board at this time is Mr. Neil Bannatyne, who, being eligible, offers himself for re-election. Messrs. Gane and Jackson, the auditors, who were elected at the extraordinary general meeting in May, also retire, and offer themselves for re-election.

United River Plate Telephone Company (Limited).

Report of the Directors to be presented to the shareholders at the third ordinary general meeting to be held at Winchester House, 50, Old Broad-street, E.C., on Thursday, the 8th August, at 12 o'clock.

The result of the Company's operations during the year ended 31st March last, after paying all working expenses abroad, debenture interest, London and other charges, is a profit of £32,850. 13s. 10d., from which has to be deducted the sum of £14,689. 6s. 8d. for loss on exchange, leaving a net profit of £18,161. 7s. 2d., increased by the balance of £1,666. 2s. 6d. brought forward from the previous year, to £19,827. 9s. 8d. Out of this

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an interim dividend of 3 per cent., or £8,250, was paid in January last; and the Directors recommend that out of the remaining balance of £11,577. 9s. 8d., a further dividend of 3 per cent., or 3s. per share, free of income tax, be now paid, which absorbs £8,367. 2s. 6d.; that £2,000 be placed to the depreciation and renewal fund, thereby increasing it to £7,000; and that the balance of £1,210. 7s. 2d. be carried forward to the credit of profit and loss account for the current year.

The Directors record with satisfaction that the 5,000 new Shares referred to in their last report, and offered to the shareholders *pro rata* in August last, were readily subscribed for, and the shareholders will observe that the capital expenditure during the year amounted to £35,070. 2s. 11d., which, however, includes the purchase of the additional business at Rosario, mentioned in the directors' last report, and to meet the cost of which, 3,000 shares were issued to the vendors, the share capital issued being thereby increased to £290,000, as shown in the balance-sheet. With this purchase, and the amalgamation consequent on it, the Company's business at Rosario is fully consolidated; and the further capital expenditure during the year has placed the Company's whole system in the Argentine Republic on a sound and efficient footing.

The Directors have pleasure in pointing out that, as shown by the figures in the balance-sheet and profit and loss account, the business of the Company has steadily and considerably developed and increased in the past year, the gross receipts in the River Plate for the year having been £81,866. 2s. 4d., as against about £66,092 for the preceding twelve months. The net results, however, has been effected by the loss in exchange, an item absolutely beyond the Company's control, which amounted to £14,689. 6s. 8d., as against £10,775. 19s. shown in the previous balance sheet. The Directors are now considering the advisability of adopting measures in some degree to meet this loss in exchange, while they are glad to say that the reports received from Buenos Ayres since the 1st April continue to show a steady increase in the Company's receipts.

In accordance with the understanding at the last general meeting, Mr. George Cooper and Mr. Alfred Le Rossignol joined the Board, and have since given the Company the benefit of their experience in the River Plate.

Under the Articles of Association Mr. Frank W. Jones and Mr. Thomas Lloyd retire by rotation at this meeting. Mr. Jones, being eligible, offers himself for re-election, but Mr. Lloyd does not seek re-election. Major Henry Fitzgerald has also resigned, and while the Board has received Mr. Lloyd's and Major Fitzgerald's resignations with great regret, recognising their services to the Company, they do not propose any other gentlemen to take their place, as the Board will thus be reduced to the original number of seven, which reduction, as explained at the last general meeting, has been for some time contemplated.

The Auditors, Messrs. Cooper Bros. and Co., also retire but offer themselves for re-election.

If the dividend herein recommended be approved at the meeting on 8th proximo the warrants will be posted to the shareholders that evening.

The Anglo-American Brush Electric Light Corporation (Limited).

An extraordinary general meeting of the shareholders of this Corporation will be held at the office of the Corporation, 112, Belvedere-road, Lambeth, London, on Wednesday, the 7th of August, 1889, at 3:0 p.m., when the subjoined special resolutions, which were unanimously passed at the extraordinary general meeting of the Corporation, held on the 22nd of July, 1889, at the Cannon-street Hotel, London, E.C., will be submitted for confirmation as s ecial resolutions:—

Resolution No. 1.—"*That it is desirable to reconstruct the Anglo-American Brush Electric Light Corporation (Limited), and that with a view thereto the Corporation be wound up voluntarily, and that J. B. Braithwaite, jun., and E. Garcke, be, and they are hereby, appointed liquidators for the purposes of such winding up.*

Resolution No. 2.—"*That the said Liquidators be, and they are hereby, authorised to consent if required to the registration of a new Company, to be named 'The Brush Electrical Engineering Company, Limited,' with a Memorandum and Articles of Association which have already been prepared with the approval of the Directors of the Corporation, but which are to be subject to such alterations and modifications (if any) as may be found expedient.*"

Resolution No 3.—"*That the draft agreement submitted to this meeting and initialled by the Chairman for the transfer of the business and property of this Corporation to the new Company shall be, and the same is hereby, approved, and that pursuant to Section 161 of the Companies' Act, 1862, the Liquidators shall be, and they are hereby, authorised to enter into an Agreement with such new Company (when incorporated) in the terms of the said draft, and generally to carry the same into effect with such (if any) modifications as the Liquidators may find expedient.*"

NEW COMPANIES REGISTERED.

THE GENERAL ELECTRIC COMPANY (LIMITED).—Registered by Tamplin, Tayler and Joseph, 165, Fenchurch-street, E.C., with a capital of £60,000, divided into 7,000 First Preference Shares, 1,000 Second Preference Shares, and 4,000 Ordinary Shares of £5 each. Object: To acquire and take over, as going concerns, the business carried on under the style of the General Electric Company, at 71, Queen Victoria-street, E.C., 22, 23, and 24, Garlick-hill, E.C., and 71 and 73, Bentham-road, South Hackney, in the county of Middlesex, under the style of the General Electric Company; also the business carried on in Clegg's-court, Chapel-street, Salford, in the county of Lancaster, under the style of the Manchester Electric Works Company, and the several patents, goodwill and other assets of the proprietors of such businesses, and with a view thereto to enter in two agreements mentioned in Clause 3 of the Company's Articles of Association, and to carry the same into effect with or without alteration. The first subscribers are:—G. Binswanger, 71, Queen Victoria-street; J. H. Ward, 23, Lower Phillimore-place, Kensington; H. Hirst, 71, Queen Victoria-street, E.C.; S. Smith, accountant, 159, Milkwood-road, Herne Hill, S.E.; G. S. Joseph, 165, Fenchurch-street, E.C.; A. R. Bernhard, Hillbrow Villas, East Finchley, N.; H. Heritage, 7, Wendover-road, Harlesden, N.W. The number of directors shall not be less than four nor more than nine, and the first shall be Gustav Binswanger, Max Binswanger, and Hugo Hirst, and two directors to be appointed by John Henry Ward. The two directors so appointed shall be paid out of the funds of the company £210 in any year in which the profits of the company shall be more than sufficient to pay a dividend of 10 per cent. on the capital paid up.

The company will continue to be a private concern and the management remains unaltered.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended July 26, 1889, amounted to £3,163, as compared with £4,592 last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of July, 1889, amounted to £54,248, and to £48,735 in the corresponding period of 1888, or an increase of £5,513.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of July, 1889, amounted to £42,876, and to £35,233 in the corresponding period of 1888, or an increase of £7,643.

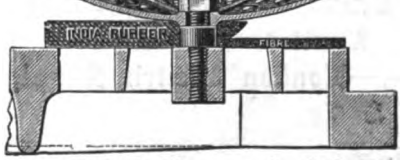
UNITED RIVER PLATE TELEPHONE COMPANY.—The report of the directors of this company for the year ending the 31st of March announces a further dividend of 3 per cent., or 3s. per share, tax free, recommending that £2,000 be placed to the depreciation and renewal fund, thereby increasing it to £7,000, and that £1,210 be carried forward.

WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY.—A half-yearly interim dividend at the rate of 6 per cent. per annum on the Preference Shares has been declared by the directors of this company, payable August 1.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended July 26, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £1,697, as compared with £3,864 last year.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, July 31, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending July 31, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	2½%	Anglo-American ... xd	52 53	3 14 1	Jan., Apr., July, Oct.	53	52½
2,614,820	Stock	5%	Do. Preferred ... xd	88 89	4 7 7	,, ,,	91	88½
2,614,820	Stock	...	Do. Deferred ...	18 18½	...	February ...	18½	18½
130,000	£10	10%	Brazilian Submarine ...	13 13½	5 3 8	Mar., June, Oct., Dec.	13 7/8	13⅜
112,900	£100	5%	Do. 5 per Cent. Bonds ... xd	102 104	4 16 2	January and July ...	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906) ...	106 109	4 11 9	June and December.	..	...
16,000	10	9%	Cuba Submarine ...	14⅜ 15½	5 18 0	February and August	...	...
6,000	10	10%	Do. Preference 10% ...	20 21	4 17 6	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid) ...	3½ 4	...	March & September	...	...
6,000	5	10%	Do. Preference 10% ...	8½ 9½	5 5 3	April and October ...	...	..
60,710	20	3½%	Direct United States ...	10½ 10⅝	5 1 5	Jan., Apr., July, Oct.	10⅞	10⅝
380,000	10	5%	Eastern ... xd	13½ 13½	4 15 7	,, ,,	13 1/16	13⅛
70,000	10	6%	Do. 6 per Cent. Preference ... xd	15 15½	3 17 5	,, ,,	15⅜	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock ...	108 110	3 12 9	May and November.	109½	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899 ...	108 111	4 10 1	February & August	108⅝	...
250,000	10	5%	Eastern Extension ...	13½ 13½	4 15 5	Jan., Apr., July, Oct	13⅜	13⅛
320,000	100	6%	Do. 6 per Cent. Debentures, 1891 ...	104 106	5 13 2	February & August	105¼	104½
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900 ...	102 105	4 14 4	January and July ...	105½	..
179,177	10	6%	Globe Telegraph and Trust ...	8⅜ 8⅝	4 15 9	Jan., Apr., July, Oct.	8⅞	8½
178,992	10	6%	Do. 6 per Cent Preference ...	14⅞ 15⅛	3 19 4	,, ,,	15 1/16	14⅞
150,000	10	7½% for '88	Great Northern ...	15 15¼	4 12 4	Jan., July, and April	15 3/16	15
17,000	25	15%	Indo-European ...	40 42	6 1 6	April and October ...	..	....
9,000	8	5%	Reuter's ...	6¾ 7¼	5 10 2	April and October ...	7¼	7⅛
15,609	10	3/0	West African Telegraph ...	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures ...	101 104	4 16 2	March & September	...	...
30,000	10	6% for '88	West Coast of America ...	10 10½	.	January and July ...	10½	10
150,000	100	8%	Do. Debentures 8% ...	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama ...	2¼ 2⅜	...	...	2 7/16	2 5/16
34,563	10	12/0*	Do. 1st Preference 6% ...	11⅞ 12¼	...	April and October ...	12⅛	11 11/16
4,669	10	†	Do. 6 per Cent. 2nd Preference ...	14 15	...	...	...	...
45,181	15	6%	Western Brazilian ...	11 11½	6 10 4	March & September	11 5/16	11
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage ...	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds ...	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	7%	Consolidated Telephone and Maintenance ...	¾ 7/8	...	Yearly ...	...	...
220,000	£1	3%	Oriental (11s. paid) ...	¼ ⅜	4 8 3	...	...	...
80,000	5	25%	United ...	15 15½	5 12 11	June and December	15 1/16	15
55,000	5	3/0	United River Plate ...	5⅜ 6¼	...	January and July ...	6¼	6
			ELECTRIC LIGHT.					
23,003	5	..	Anglo-American Brush (£4 paid) ...	3¼ 3⅜	...	...	...	...
23,692	5	...	Do. (fully paid) ...	4⅛ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid) ...	4¼ 4½	...	...	4⅝	4⅜
			MISCELLANEOUS.					
37,350	12	30/0	Telegraph Construction and Maintenance ...	43 45	5 6 3	March and July ...	44⅛	43⅞
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works ...	19 20	5 0 0	February & August	19¼	19⅛

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 586.—Vol. XXIII. FRIDAY, AUGUST 9, 1889. Price Fourpence.

NOTES.

The proceedings before the Select Committee of the House of Lords, which is now engaged in considering the metropolitan electric lighting schemes, have not so far been of a very interesting character. One of the chief witnesses was Major Marindin, who was examined at great length on several points connected with the recent Board of Trade Inquiry. On Wednesday, after being slightly amended, the Order of the London Electric Supply Corporation was passed, in spite of the strenuous opposition of the St. James' and Pall Mall Company. Yesterday the Order of the Westminster Electric Supply Corporation was passed.

In another column will be found a letter addressed by the St. James's Vestry to the Board of Trade protesting against the handing over of the powers of the local authorities to the County Council, and very pertinently pointing out that since these powers are vested in the local authorities by the Principal Act, the action of the Board of Trade cannot do more than give concurrent powers to the County Council. A state of things which must lead to unfortunate results.

The alternate-current motor, designed by Mr. Mordey, and discussed by M. Leblanc in the Paper which we abstract from *La Lumière Electrique*, made no appearance in Mr. Mordey's recent deliverance on "Alternate-Current Working," from which (seeing also that the patent is not of very recent date) we may draw the inference that the inventor himself lays but little stress upon this particular design. Nevertheless, as representing a distinct type of motor, and one possessing certain singular advantages, M. Leblanc's investigation of the properties of the system is not without importance, and will be found by the student both interesting and instructive. In spite, however, of the advantages alluded to—including self-starting, self-excitation, great stability in speed, maximum torque and minimum impedance attained at normal speed—it is to be feared that the presence of a varying and intermittent current in the armature is a drawback which will not easily be overcome. We may add that M. Leblanc's paper follows the lines of Mr. Mordey's specification with considerable fidelity.

In the discussion of alternate-current motors, and indeed of electric motors in general, sufficient stress is seldom laid upon the distinction between the *transmission* and the *distribution* of motive power. It requires no argument to prove that these are two distinct problems. A type of motor which may prove admirably adapted for the steady conversion of electrical into mechanical energy (at the rate perhaps of some hundreds of horse-power) might easily become valueless if built upon a smaller scale and set to do intermittent work under varying conditions. The continuous-current motor has long furnished an adequate solution of the distributing problem (though it still remains absolutely without illustration in this country). But whilst little has been said about it, the fact is generally recognised that for the transmission and conversion of energy upon the larger scale with continuous currents an upward limit is soon imposed by reason of the very serious difficulties of dealing with high tension in such machines. So far as the motor itself is concerned, these difficulties make themselves apparent with continuous-current machinery at a far earlier stage than is the case with alternators, and we do not hesitate to express the opinion that if ever Sir William Thomson's vision of the utilisation of the Falls of Niagara is realised it will be by means of the alternate-current motor. We say this in spite of M. Leblanc's confident assertion that the synchronising motor (of the type identical with the generator) is necessarily inefficient. It is true that the maintenance of cophasial synchronism necessarily demands a certain expenditure of energy—it is also true that this is wasted as heat in the coils of the armature, but in the absence of direct experimental evidence it would seem that M. Leblanc is somewhat rash in asserting that this loss is necessarily so great as to seriously impair the efficiency of the system. We anticipate that Mr. Mordey will before long be in a position to throw some light upon this important point.

Since the above notes were written, we learn from the pages of the *Comptes Rendus* that M. Leblanc has himself invented and constructed an alternating motor of a novel and highly remarkable type. On another page will be found a full translation of the brief memoir in which the inventor has submitted his solution of the problem to the French Academy. It must be admitted that the absence of diagrams and the somewhat complex character of the design renders the description not altogether as intelligible as could be wished. It may be well, therefore, that we should for the present abstain from any attempt at criticism, but it is noteworthy that, in laying down the general principle that an efficient motor must have the smallest possible self-induction, the Author is (perhaps un-

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awares) following straight in the footsteps of Mr. Mordey. M. Leblanc does not, however, content himself with a design in which the mere absence of iron and the proportioning of the parts renders the armature self-induction a minimum—he goes a step further, and seeks to cancel the self-induced field by introducing at the right moment a flux of lines in the reverse direction. The action, if we have correctly apprehended M. Leblanc's project, is similar to the well-known effect which takes place in the coils of a continuous-current armature whilst they are short-circuited by the brush, and when the lead is such that the self-induced E.M.F. is just balanced by the induction of the field, in which case we get no sparking. In M. Leblanc's motor this effect is reproduced upon a larger scale, but whether it is wise or necessary for this purpose to rotate the brushes as well as the commutator is rather open to question.

Our New York correspondent, referring to the question of laminated armature cores, points out that this device was described by M. A. Pellerin in the *Comptes Rendus* (Vol. LXXVII., No. 9) as long ago as 1873. We may add that a translation of the note referred to was published in the *Telegraphic Journal* of the same year (Vol. I., p. 271) in the following terms:—

"The Siemens' bobbin has a great inconvenience, that it gives rise, in the machines in which it is employed, to a considerable development of heat, and consequently a corresponding loss of work. It is possible that the origin of a greater part of this heat is in the induction currents developed by the movement of the mass of metal forming the core of the bobbin. We avoid the production of these currents *by forming the core of discs of soft iron insulated.* The assemblage of these discs in a sufficiently solid mass is not an insurmountable difficulty."

In the light of the above quotation, there would seem to be very little chance of establishing the Edison patent of six years later.

In our recent reference to the existence of this Edison patent, and the probability of its coming prominently under notice, we need scarcely assure our readers that we had good and sufficient ground for saying what we did. A contemporary journal not happening to be in possession of our information, first charged us with raising a false alarm, and then proceeded to beg the owners of the patent, if they had any such intention, to abandon the idea of its enforcement. We take a different view of this question. If a firm or company find themselves in possession of any patent which they have reason to believe of value, we cannot conceive upon what possible ground they should be expected to forego the advantage even if it is obtained wholly at the cost of their competitors. To a business man such a suggestion must appear to verge on the childish. At the same time we fully recognise that the position of those who have infringed a patent, possibly for years, in ignorance of its existence would become very hard indeed if an attempt were made to recover royalties from the commencement; and this is a course which no firm could adopt without distinct loss of reputation. It seems to us that in such a case justice would be met—supposing the patent could be sustained by the payment of a comparatively small tribute. We are none the less pleased, as regards the particular case alluded to, above to be now able to publish an anticipation which on the face of it would seem fatal to any subsequent claim.

The Council of the Institution of Electrical Engineers is inviting the opinion of its members on the long-vexed question connected with the nomination and election of officers. So far as it goes the statement put forward by the Council is fair enough; but it fails to appreciate at their full weight the objections that have been raised to the "old" system, and which, indeed, perhaps equally apply to the "new." These objections are—firstly, that an insufficient time is allowed to challenge the nomination of the Council, supposing the members wish to exercise their undoubted right to do so; and secondly, that, waiving this right, they are still required to go through the elaborate and meaningless function of an election.

One of the alleged disadvantages of the present system of nomination is that it deprives the Council of the services of some very desirable candidates, who absolutely decline to be put in competition. In other words they are willing to be nominated by the Council, but refuse to be elected by the members. If this feeling prevails generally among "men of high scientific attainments" it goes to prove that the election system is altogether a wrong system, and we are not disposed to dispute the proposition. What we do dispute is the expediency of keeping up the pretence when the reality has been frankly abandoned.

Despite the marvellous success of the phonograph as a piece of mechanism, persons have been known to raise the question whether its practical every-day utility is likely after all to prove of much importance, and the long delay in launching the venture on the commercial world lends some additional weight to such forebodings. We are therefore happy to signalise in our columns the fact that M. Firmin Larroque has indicated a field of usefulness for the phonograph, whose importance to the engineering world it is difficult to over-estimate, though, unhappily, the extent of the probable demand for the apparatus will not be much enhanced. It is admitted that the life of an iron or steel bridge cannot be indefinitely prolonged, and yet engineers do not possess any completely satisfactory method of determining the actual condition of these important structures. So long as no actual deformation has taken place, the iron may here or there be assuming a crystalline condition, or may be seriously oxidised underneath the coating of paint, and yet the extent of the evil can easily remain undiscovered. M. Larroque proposes a remedy. His suggestion is to employ the phonograph in connection with a microphone and telephone to register the nature of the vibrations of the bridge as a whole or in sections under a rolling load, and to preserve the record for comparison with subsequent tests carried on at regular intervals. The direct comparison of two phonographic records cannot be carried out with sufficient accuracy, M. Larroque, therefore, employs an optical method, and reflects a beam of light from the vibrating plate, after the manner of the well-known Lissajou's figures. It would, of course, be

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necessary to secure a long series of such records before the results would be capable of complete interpretation, but it certainly seems quite possible by such means to obtain reliable indications of a change in the molecular structure of the material.

In our last issue we unwittingly did some injustice to M. Hermite in speaking of his electrolytic sewage disinfectant process as subsequent in date to that of Mr. Webster. On a comparison of the English patents we find that the specifications were filed at nearly the same period, but that M. Hermite's was actually the first of the two to be accepted and published. We hope shortly to give some further details of the Hermite process.

Truro.—It is stated that the Truro Gas Company have applied to the Board of Trade for a Provisional Order to enable them to light the town and its vicinity by electricity.

Stockton.—The Electric Light and Power Corporation and the Northern House-to-House Electricity Company have given notice of their intention to apply for Provisional Orders.

Personal. — The Professorship of Civil Engineering and Mechanics in the University of Glasgow is likely to be vacant by the resignation of Prof. James Thomson on account of ill-health.

The International Congress.—The first meeting of the Congrès International des Electriciens will take place at 10 a.m. on Saturday, August 24th, in the Salle des Congrès et Conférences at the Trocadéro.

The Electric Lighting of the Japanese Houses of Parliament.—A contract for 350 electric lights to illuminate the Japan House of Parliament has been placed with the Tokyo Electric Light Company.

Electrical Tenders.—It will be seen by our advertisement columns that the London County Council invites tenders for making perfect and maintaining for one year all the wires and apparatus connected with the London Fire Brigade.

Engineering Courses.—The 1889-90 Session of University College, Nottingham, begins on October 7th, and special facilities are offered to students in electrical engineering. Further particulars with respect to the courses will be found in our advertisement columns.

Errata.—In paragraph three of Mr. J. D. F. Andrews' letter, which we published last week, the word "charges" should read "changes." "Magnetic leads," in the sixth paragraph, should read "magnetic blades"; and "leaders," in the seventh paragraph, should read "blades."

Airdrie.—At its monthly meeting, held on Thursday last week, the Council unanimously adopted a recommendation by the Lighting Committee to the effect that the Council should apply for a Provisional Order empowering them to light the burgh with electricity on their own account.

Tyldesley.—At the last meeting of the Tyldesley Local Board notice was received from an electric lighting company that they intended to apply to Parliament for a Provisional Order for the district. The Clerk was instructed to inform the company's solicitors that the Board intended to oppose the application.

Coventry.—At a meeting of the Town Council last week the Midland House-to-House Electricity Company gave notice of an intended application for a Provisional Order. The Council decided to oppose the application. Alderman Gulson said the Corporation having the gas monopoly, it would be absurd on their part to encourage a rival of that monopoly.

Wrexham.—At a recent meeting of the Wrexham Town Council a letter was read from Mr. F. Vaughan Hughes, of Chester, who wrote on behalf of the Wrexham and District Electric Supply Company to inform the Council that they intended to apply for a Provisional Order. Mr. Hughes said it was a local company and was supported by local people.

The Priestman Oil Engine.—We learn that the Northern Lighthouse Board have adopted the Priestman Oil Engines for blowing fog signals in preference to steam or gas engines. These engines are evidently well suited for such a purpose, no chimney being required as in the case of a steam engine, and gas being seldom available unless special works are erected.

Lancashire County Council.—At the last meeting of the Lancashire County Council the Clerk reported the receipt of a notice of intended application to Parliament by the Anglo-American Brush Corporation for a Provisional Order. The area of the proposed operations was Didsbury, Withington, Heaton Norris and Reddish Local Board Districts. The matter was referred to the Parliamentary Committee.

Tours.—The town of Tours, which was one of the first provincial towns of France to have a central lighting station, is the first to have luminous fountains, two of which have been installed on the Place du Palais. The electrical arrangements were entrusted to the Compagnie Internationale d'Éclairage Électrique, and the four 40-ampere arcs with horizontal carbons are run off alternate-current transformers.

The Glasgow District Telephone Directory.—The 1889-90 edition of this useful publication has attained the respectable dimensions of over 300 pages. The subscribers, in addition to being arranged alphabetically under their respective exchanges, are also classified according to professions and trades. The Directory contains full particulars with regard to rates of subscription, trunk wire tariff, the erection of private wires, as well as other useful information.

The Electric Launches on the Thames.—The Prince of Wales ran up the river a few days ago in Messrs. Immisch and Co.'s electric launch, the "Viscountess Bury." Starting from Kew Bridge for Sunbury, a visit was paid to Platt's Eyot, where the above-mentioned firm has a charging station. An electric torpedo boat in course of completion attracted some attention, and after a trip in several of the smaller launches the party proceeded down the river, landing at Chelsea.

Presentation to Mr. Mackay.—The staff of the Commercial Cable Company on Christmas Day last presented Mr. John W. Mackay with a magnificent silver piece, as a token of their regard for him. It was accompanied by an appropriate address. Since then the address has been engrossed in a very beautiful album and signed by every member of the staff, and a few weeks back a committee of about a dozen waited upon Mr. Mackay and made the formal presentation.

Proposed Electric Railway for Eastbourne.—The Mayor of Eastbourne has just received a requisition, signed by a number of the leading business men of the town, requesting that a meeting may be called at an early date at the Town Hall to allow of the preliminary consideration of the proposed electric railway along the sea front from the Wish Tower to Beachy Head, by way of Holywell Rocks, a distance of nearly two miles. The Mayor will next week convene the meeting desired.

Mayfield and Co.'s Catalogue.—The greater portion of this catalogue is devoted to laboratory and lecture apparatus, and contains a very complete list of electroscopes, electrometers, Ruhmkoff coils, vacuum tubes, &c. The rest of the catalogue relates to domestic electrical apparatus, and includes dynamos, accumulators, gas engines, bells, batteries, and switches. Amongst other things we notice an improved burglar alarm, a double-lock indicator, and some handy direct-reading pocket ammeters and voltmeters.

The Telephone in Berlin.—The following table, showing the number of telephone subscribers in Berlin at different dates, gives an idea of the rapid development of the telephone service in that capital:—

Date.	Subscribers.	Date.	Subscribers.
April 1, 1881.....	50	End of 1885.....	4,324
End of 1881.....	458	,, 1886.....	5,507
,, 1882.....	1,069	,, 1887.....	6,954
,, 1883.....	1,625	,, 1888.....	9,199
,, 1884.....	2,412	April 1, 1889.....	9,534

Present time upwards of 10,000 subscribers.

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A Meteorological Congress.—The Société Meteorologique de France has arranged a Congress, which is to be held in Paris from the 19th to the 25th September. The programme contains the following amongst other questions for discussion:—Magnetism: The Relation between Magnetic Phenomena and Earthquakes; the Study of Earth Currents; Magnetic Observations at Sea. Electricity: The Methods of Observing Atmospheric Electricity; the Relations between Electricity and other Meteorological Elements; the Aurora.

Cooking by Electricity.—The Hotel Bernina, at Samaden, has for some time been lighted with electricity, power being supplied by a waterfall. As during the day this power is not required for lighting, and is therefore running to waste, the proprietor of the hotel has hit upon the idea of utilising the current for cooking when it is not required for lighting, and an experimental cooking apparatus has been constructed. This contains German silver resistance coils, which are brought to a red heat by the current, and it has been found possible to perform all the ordinary cooking operations in a range fitted with a series of such coils.

Chelmsford.—It is hoped that Messrs. Crompton and Co. will be able to commence their contract for the lighting of the town some time in September. As will be remembered, the main streets are to be lighted by eighteen 1,000 candle-power arcs and the remaining portions of the town by two hundred 32 candle-power incandescents. The incandescent lamps are to be fixed in lanterns, which will hang from brackets about 15 to 20ft. high. The arc lamps will be suspended between poles, about 25ft. high. The wires will be carried overhead at the height of about 25ft. The generating station is being built under the new offices of the company at the works, and the foundation for the machines has been laid some time. The lighting will be carried out by alternate-current transformers.

The Telephone in Italy.—According to a Bill at present before the Italian Parliament, telephone exchanges are only to be worked under Government concessions or by the Government itself. The maximum annual subscription for town service is fixed at 200fr. for all instruments within three kilometres from the exchange. For distances beyond this 3fr. extra for every 100 metres for the first two kilometres, and 2fr. for every 400 metres over five kilometres from the exchange. Government, Provincial, and Communal authorities are to have a rebate of 30 per cent. The maximum tariff for inter-urban communication is to be 1fr. 50c. for every five minutes' conversation over short wires, and 2fr. beyond a distance of 100 kilometres. The Government may temporarily suspend or restrict the telephonic service for reasons of public safety.

The Electrolytic Preparation of Iodine.—Messrs. Parker and Robinson have brought out a process of precipitating iodine from its metallic compounds by electrolysis. The vat containing the electrolyte is divided by a porous partition, one division containing the anode of carbon or platinum, and the other the cathode of iron. The anode is surrounded by an aqueous solution of some metallic compound of iodine, to which is added either hydrochloric or sulphuric acid. The cathode is surrounded by an alkaline solution. The current density usually employed is ·125 ampere per square inch of plate. Under the action of the current the iodide is split up, hydroiodic and iodic acid being formed in succession. These acids finally give up their iodine, which is deposited at the anode, in virtue of its almost complete insolubility in water. It is collected by decantation and purified in the ordinary way.

High-Tension Currents.—In the present turmoil in this country on the question of safety as between the continuous and alternating currents, perhaps the most striking aspect of this Electrical Saurian, says the *Electrical Review* of New York, is the calmness with which enormous pressures are discussed by its English projectors. Our alternating-current systems are, we believe, mostly operated at a pressure of 1,000 volts, though some of them double that figure. But here comes the slow and conservative English capitalist and puts his money into a stupendous plant which is to make a total eclipse of our largest stations, and this is to be all done at the tremendous pressure of 10,000 volts! And this is not the scheme of some visionary feather-weight, nor the attempt of any electrical Icarus to reach the sun of notoriety, but it is the deliberate decision of some of England's foremost and most practical electrical engineers.

An Incandescent Lamp Slide Rule.—The Edison-Swan Company have brought out a slide rule, designed by Dr. J. A. Fleming, for performing with great readiness any of the usual calculations with regard to incandescent lamps. It consists of a rule carrying four similar scales, marked respectively (1) Amperes; (2) Volts; (3) Candle-power; (4) Watts per candle-power. Two of these scales, viz., the first and fourth, are engraved on the rule, and two, viz., the second and third, on the slide. There is also a brass slider having a reading point. The calculations which may be done by this rule are as follows:—(1) Given the current through a lamp, the terminal volts, and the candle-power, find the Watts per candle-power. (2) Given the Watts per candle-power and the candle-power, find the current corresponding to any voltage. (3) Given the volts and the current, find the hot resistance of the lamp. (4) Given the volts and current when the lamp is burning at normal brilliancy, find the candle-power approximately. This ingenious slide rule will no doubt be of great use to all those engaged in incandescent lighting.

The Melipuli-Punta-Arenas Cable.—The Chilian Government have just issued a decree relating to the laying of a new submarine cable between Melipuli and Punta-Arenas. All tenders must be in the hands of the Minister of the Interior at Santiago by the 30th November next. Other things being equal the contract will be awarded to whoever submits the best specimen of cable, engages to lay the cable within the shortest period, and gives the most reliable guarantee for the execution of the contract. The contractor will be responsible for the proper working of the cable for one year after the completion of the work. All tenders must be accompanied by a deposit of 5,000 pesos (£1,000). The cable is to start from Melipuli (Puerto-Moutt), and to touch at Palena, at the mouth of the river Buta-Palena; it will run thence to Port Otway, across the Gulf of Las Penas to Munoz-Gamero, thence through the Straits of Magellan to Punta-Arenas (Sandy Point). When laid this cable should bring a good deal of traffic to the West Coast of America Company.

Electricity in Powder Mills.—The German technical journals have recently published some instructions as to the precautions which ought to be observed in powder mills to prevent explosions from electrical causes. The necessity for some such precautions is clearly shown by recent explosions, several of which are attributable to electricity. In a large powder mill, in Germany, an explosion lately occurred in the press room. A workman engaged in pressing powder into cakes between sheets of ebonite, left his work during a thunderstorm. When the storm was over he loosened the press, and on putting out his hand to remove the powder, a spark 4in. long went to earth through his body, igniting the powder, and killing the man. The employment of insulating substances, such as gutta percha, ebonite, &c., is therefore considered as likely to lead to accidents. In the powder mill of Herr W. Gutler the sulphur crushing machines are all put to earth, and since this precaution has been taken there has been no trouble from the mysterious explosions which had previously proved so troublesome.

City of London and Southwark Subway.—The directors of this company, in their report, state that the whole of the tunnels from the City to a point considerably beyond the Kennington Oval Station, a distance of about 2¾ miles, have been completed, and the main underground works at the King William-street, Great Dover-street and Stockwell Stations have also been finished, and those at the other three stations are in a forward state. The station buildings on the surface at Great Dover-street and the Elephant and Castle have been commenced, and the necessary alterations of the buildings at King William-street to fit them for the City station are nearly completed. A short piece of tunnelling about 250 yards in length, between the Oval and the terminus at Stockwell, is still incomplete, owing to the existence of a wet bed of gravel through which the work is being carried on under air pressure, a slow and tedious process. The rails are now laid in the tunnels between King

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William-street and Great Dover-street, and an experimental train worked by electricity is nearly ready for trial on this section.

A Peculiar Earth—A short while ago it was noticed, at Boston, U.S., that the horses were very uneasy when passing over an area of, say, 10ft. square in the granite pavement of Boylston street. An investigation by the Edison people seemed to show no trouble, and everything went right for ten days or more, when, during a rain-storm, the same action of the horses was noticed. Upon digging down to the wires, which were embedded in a bitumen compound, a spot was found where the box was eaten through. The insulation of the negative wire was found to be destroyed, and as the neutral is earthed in the station there was a leak sufficient to affect horses as well as men. Chemical examination of the insulation at the fault showed that it was orignally concentrated lye, which had become partly converted into caustic soda by water, and that the action of the currents had, by electrolysis, formed a considerable quantity of metallic sodium throughout the mass. It is supposed that in some way a piece of lye tumbled into the kettle in which the insulating compound was made and was not noticed. Hence the trouble.

Kingston-on-Thames.—A private conference of the representatives of the various local authorities in the district took place at the Kingston Town Hall on Monday last week to consider whether united action could not be taken with reference to the applications about to be made by various electric lighting companies for powers to supply the neighbourhood with the electric light. It was resolved to oppose the applications of the companies, with a view to the local bodies obtaining powers themselves to supply the light; and the meeting was adjourned for a fortnight to decide upon what steps should be taken. Later on in the week a long report on the subject was presented by the General Purposes Committee of the Kingston Town Council, in which it was stated that it was clearly the duty of the Corporation to refuse to give consent to any company unless it possessed ample capital to supply the whole area it sought to acquire, and the report concluded by recommending that the neighbouring local authorities should unite for the supply of the district generally.—The report was adopted unanimously.

An Electric Census Machine.—Electricity is to be put to a new use in the forthcoming census in the United States. The census collector will call with his printed blank, and answers to questions will be written in the usual way. These sheets will then be placed before a person who operates a machine which may be likened to a typewriter, except that, instead of the usual ink marks on paper, small round holes are punched in a card. The cards, one for each person, are about 6½ inches in length by 3 inches in width, and the particular position of hole in a card indicates an answer to some of the questions in the printed blank. These cards, when punched, are placed one at a time in a sort of press, and a lever operated by hand is brought down, when a series of pins are brought against the card. Whenever a hole has been punched in a card, the corresponding pin passes through into a mercury cup beneath completing an electric circuit. These circuits, one for every hole, include a large number of counters which operate electrically, and which add upon their dials all items of the same kind upon the same dials. For instance, all white men are counted upon a dial marked "white males;" all business or professional people upon dials which indicate their particular business or profession. The cards, as they leave the press, are all sorted by means of an electrical sorting device, whereby they may be separated into groups or States of the Union.

Bedford.—The Bedford Electric Lighting Company, in offering to undertake the establishment of the electric light in Bedford, submitted for the consideration of the Corporation the following propositions suggested by Sir Henry Mance:—

"In consideration of the Bedford Corporation affording all reasonable facilities to the company for their operations and, as far as possible, securing to them a monopoly so long as the service is efficiently performed by the Bedford Electric Light Company in accordance with the stipulated conditions, the latter agree to give the Bedford Corporation every five years the option (on giving one year's notice) of purchasing the undertaking at a price not exceeding twenty years' purchase of the profits, the profits to be estimated on the results of the last year's working, or an average of the last five years, whichever may be most favourable to the company. In calculating the profits any gains derived from contracts for public lighting would be excluded. It is, however, provided that should the company not have paid an average of 5 per cent. on its share capital during the time it may have been in operation, the purchase money paid shall not be less than the par value of the shares and debentures, together with such sums as may enable the directors to pay 5 per cent. on the share capital from the commencement. If desired, the company would allow one director to be nominated by the Corporation; they would agree to commence operations within six months, and undertake to be in a position to light the principal thoroughfares before the end of the first year. On reasonable notice being given, they undertake to extend the arrangements for private supply to outlying districts as soon as 25 per cent. of the residents require the light. All posts required for public lighting to be erected by the Corporation. The price to be charged for the light *not to exceed*: For any number of arc lights (not less than 30) of 1,000 candles nominal for public lighting, 3d. per hour each; arc lights for private use of similar power 6d., per hour each; incandescent lamps supplied by meter per Board of Trade unit, 10d. per unit. In the event of the Corporation preferring not to enter into any special arrangement which would enable them to acquire the undertaking every five years, the company were quite prepared to commence operations on receipt of permission to cross the river with cables or the streets with wires, as is done with the telephone wires at present, it being also understood that permission to lay the wires underground, should such a course be eventually necessary, would be given when consistent with public convenience."

Electricity on War Ships.—At a recent meeting of the Naval Institute in Annapolis, Mr. S. D. Greene, electrician of the Sprague Company, read an interesting Paper entitled "Electricity on board War Ships." The opening remarks were devoted to the question, Who should have charge of the laying out and installation of the electric plant for a ship? At present each bureau in the United States Navy department has charge of the apparatus belonging to its department on board ship. Such arrangement would obviously be most unsatisfactory in the case of the electric plants, and Mr. Greene dwelt with a deal of force upon the necessity of having all the electric apparatus under one head, both in its designing and in its practical operation. The dynamo room, where a large plant is used, had now become one of the vitals of the ship, and hence must be afforded all the protection that the type of vessel allows. Importance was attached to the necessity of having all engines and dynamos duplicates of each other. Under the heading of the wiring and lamps several suggestions were made, based on experience gained ashore. The use of a lead covering on the wire, to act as a mechanical protection, was condemned on account of its liability to break when handling. As a substitute it was suggested to use either an armoured wire, such as is used in submarine work, or else a plain, bare wire, run in a continuous slate or porcelain trough. The various classes of work done by the auxiliary engines of a ship were next enumerated in detail, and it was shown how motors could be used to advantage instead of steam or hydraulic machinery in each case, and what type of motor was best suited for the particular work in question. Attention was drawn to the fact that an ammunition hoist had recently been put on board the "Atalana," operated by a motor, and that one of the gun carriages of the "Chicago" was being fitted with a training motor and an elevator motor. These were the first two applications of their kind. A contrast was drawn between the complicated task of running steam pipes all over the ship, and the easy, simple operation of running electric wires. The advisability of increasing the number of search lights on the new American war-ships was shown, together with the use of these lights for long-distance signalling. One of the latest electrical devices described was the new range finder invented by Lieutenant Fiske. The use of firing circuits for firing the main battery of a ship was strongly argued. In action, with the ship rolling, the gun captain must be able to fire his gun the instant the sights fall on the object aimed at, and electricity is the best known agent to accomplish this. In addition, there are times when a commanding officer will himself want to fire his whole battery simultaneously, and he can do so best by pressing an electric button.

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ON THE DISTRIBUTION OF ENERGY BY MEANS OF ALTERNATING CURRENTS.*

BY M. LEBLANC.

(*Continued from page 321.*)

Mr. Mordey's Motor.—Mr. Mordey has some time since designed an alternate-current motor in which any suitable continuous-current type of machine may be employed. It is, however, necessary that the field magnets should be built up of laminated iron. This is not because the alternate current itself is used to excite the field, but for a reason which will presently appear. In addition to the usual commutator and collecting brushes, the machine is provided with a second commutator, consisting essentially of the old-fashioned halved-ring—the two-part commutator as it is sometimes called. The two halves of this ring are connected (through suitable collecting rings and another set of brushes) with the brushes which bear upon the commutator belonging to the motor itself. The brushes which bear upon the halved-ring commutator are those which convey the alternating current. It will now be seen that if the motor run at a speed corresponding to the periodic time, the alternating current, after having traversed the first commutator, will have its two opposite phases brought into the same direction. In practice we could not conveniently make use of a mere two-part commutator, as this would demand a tremendously high velocity. We may, however, employ any convenient number of segments connected alternately in pairs.

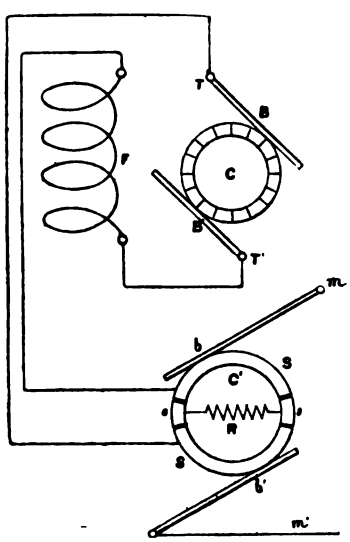

FIG. 5.

The action will be understood from the above diagram (Fig. 5):—C is the commutator of the continuous-current dynamo with its field-magnets in series, and C_1 is the "two-part" commutator of which the segments S S are connected directly with the brushes T T of the motor. The connection is made by a separate pair of brushes and collecting rings, which are not shown in the diagram. The alternate current is led into the commutator from the terminals *m m'* by the brushes *b b'*. Between the segments S S are two smaller segments, *s s*, which are connected by a resistance, R; this is to avoid short-circuiting the mains at the moment of reversal. It will now be seen that when the motor is running, until it has acquired its normal speed, the field-magnets F will receive an alternating-current; but as the velocity increases the commutator C_1 gradually transforms this in the motor circuit into a current uniform as regards direction.

In a motor so designed the value of the coefficient of self-induction appears to diminish as the speed increases; it attains a minimum when the alternating current has been fully commutated, and from this point it again increases as the speed rises. The torque at first increases with the speed, attains a maximum at the point of normal commutation, and then again diminishes. It is easy to see that this arrangement possesses several practical advantages. In the first place it is self-starting. Secondly, the self-induction of the system being high at the outset we have no need to close the circuit upon an intermediary resistance. The speed gradually accelerates, but it cannot exceed (to more than a slight extent) the normal value at which the commutation is perfect, for if it does the self-induction increases, the current is choked off, and the torque diminishes. Hence also the machine can never "race," and the load may be varied from zero up to the point at which its maximum torque is counterbalanced without sensibly varying the speed.

This machine would seem therefore to furnish an excellent solution of the problem of the alternate-current motor, but unhappily, such as it is, it presents all the disadvantages inseparable from the "redressed" current; and we are thus, so far as the continuous-current motor is concerned, little better off than we were in the days before Gramme taught us how to obtain a current *quasi*-continuous in form. The two-part commutator is, moreover, a feature which cannot be wholly commended. In order to avoid difficulties of sparking and of the nice adjustment of the brushes, Mr. Mordey resorts to the device of interposing two short segments, *s s* (Fig. 5), connected together by a resistance, R. This device avoids the short-circuiting of either generator or motor at the moment when the brushes change segments; but, on the other hand, the circuit of the motor will now remain open so long as the brushes rest upon the intervening segments, so that it is open to question if the remedy be not worse than the disease. The energy lost in the resistance R is not of much consequence, because the alternating current is at that moment passing through zero value.

From what has been already said, we may arrive at the following conclusions:—

1. An ordinary alternator employed as a motor possesses the important advantage that the additional resistance and impedance introduced into the circuit of the generator is small. But it must be separately excited, and its synchronism cannot be maintained without a certain loss of energy, which is dissipated as heat in the armature. This system is not therefore capable of rendering a high efficiency.*

2. The machines of the type of the Tesla and the Elihu Thomson motor possess several very interesting features, some of which are practically advantageous. But the effects of self-induction which occur considerably augment their impedance, and render them unsuitable for the transmission of large forces.

3. In Mr. Mordey's machine the self-induction effects are positively advantageous as regards the development of the torque on the shaft of the motor, but, nevertheless, we have to employ what is actually an *intermittent* as well as a varying current in the circuit of the motor, and we cannot therefore expect to obtain results comparable with those of a continuous-current.

(*To be continued.*)

* Abstracted from *La Lumière Electrique*.

PARLIAMENTARY INTELLIGENCE.

The Select Committee of the House of Lords on the Metropolitan Electric Lighting Schemes.

TUESDAY, AUGUST 6.

The Select Committee of the House of Lords appointed to consider the Bills for confirming Provisional Orders granted by the Board of Trade for supplying electric light to the metropolis met to-day. The chairman is the Earl of Limerick, the other members of the Committee being Lords Lauderdale, Lindsay, Ellesmere, and Clavenagh.

Mr. PEMBER, Q.C. (with whom were Mr. Moulton, Q.C., and Mr. Loyd), addressed the Committee on behalf of the London Electric Supply Corporation. After describing the system proposed to be adopted by the Corporation, he referred to the opponents, and challenged the *locus standi* of the St. James's and Pall Mall Electric Light Company (Limited), and of the City of Westminster Electrical Syndicate (Limited).

* It is permissible to question whether, in the absence of direct experimental evidence with modern machines, this decision is as yet wholly justifiable.—ED. *E.*

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The latter case was argued first, Mr. LITTLER, Q.C., contending for the Syndicate that even the London Supply Corporation had no right to be there, as they had not the consent of the local authority, and the special report required by the Act where the Board of Trade consider that such consent should be dispensed had not been made.

Mr. PEMBER replied, and the Committee, after deliberation, held that the *locus standi* of the Syndicate had been established. The objection to the locus of the St. James's and Pall Mall Company was not proceeded with.

The EARL OF CRAWFORD AND BALCARRES was then called, and in reply to Mr. LOYD, said they were supplying about 30,000 lights at the present time, about 6,000 being in St. James's. They had been supplying current in St. James's for a considerable time. With regard to the St. James's Company, the Board of Trade had held an inquiry in accordance with the Act, and the Inspector had recommended that there should be two companies in the district, and by that decision his company claimed to abide. He was against any monopoly. The St. James's Company would not be affected except that they would not get so many customers. That company had no mains laid down at the time of the inquiry, but they had been pushing on with great activity since. He first became aware of the City of Westminster Syndicate when they petitioned the House of Lords. He ought to have known more about them, but he was under the impression that the works used by them were the works of another company. They had received a very large number of requisitions to supply in Westminster, especially about the region of Victoria-street.

Cross-examined by Mr. BIDDER, who appeared for the St. James's Company: He considered they had been very modest, as their original demands had been reduced by one-half. Their capital of a million and a-quarter would not provide all the works to adequately and fully supply the whole of their district. On a large scale he believed they could put down and distribute light at an expenditure of about £1 per head, so that it would require about double their present capital. With regard to the compulsory streets, he would rather not have had them, but in most cases they were streets where he would have gone of his own accord. It was stated at the inquiry that the alternating system was not suitable for motors; but the contrary had since been demonstrated. In order to stave off Parliamentary opposition they had agreed with the Chelsea Company not to go into certain streets in Chelsea except upon requisition. He could not enter into a similar agreement with the St. James's.

Cross-examined by Mr. BATTEN, on behalf of the City of Westminster Syndicate: The Board of Trade has already taken away a large portion of his area, and he could not consent to give up more.

Re-examined by Mr. LOYD: There were companies in competition with them over the whole of the area north of the Thames. There was nobody in competition with them on the south of the river; but he was given to understand that a good number of notices had been put in on the south of the river for next year. With the plant on order they would be able to supply about 450,000 lights. If the engines were ready, and capable of giving out current at once for 400,000 lights, it would be certainly impossible for the trade to wire houses sufficient to receive that current under six or eight months. Their plant was more than sufficient to supply the demand at the present time, or even within the next three or four months. The Deptford station was intentionally so planned as to admit of duplicating and reduplicating the plant. Compulsory streets having been mapped out by the Board of Trade, the requisition was the common-sense way of making the supply follow the demand as to the remainder of the district. Since the inquiry there had been a public demonstration by the Brush Company that it was possible to work motors by alternating currents.

Major MARINDIN, R.E., was then called.

Mr. BIDDER objected that it would be irregular to examine Major Marindin upon his report, which was his judicial utterance.

The Committee having deliberated upon this point,

The CHAIRMAN said: The Committee are of opinion that it is quite competent to call Major Marindin. To the Witness: If you think any question put to you would fetter the examinations you may have to hold hereafter, if you would bring that point before the Committee, the Committee would consider whether the question should be put.

Major MARINDIN was then examined by Mr. Loyd. He said that he considered districting was necessary where there were two alternating companies in the same district. Where a parish agreed to the entrance of electric lighting companies, he thought, for the present at any rate, they should be limited to two, for reasons given in his report; and where there were two companies he thought it desirable (because the evidence before him was to the effect that there was no motor for alternating currents) that one of those companies should be alternating and one direct. Between two alternating companies he thought it better to district than to allow two alternating current systems to occupy the same area, which would possibly have the effect of excluding the direct supply. He had nothing to do with the St. James's Company. They had their license and were in the St. James's area as a direct company. He did not think it desirable to put two more companies in that area, and he had therefore to elect between the Metropolitan and the London. His reason for selecting the London was this:—In districting between the two companies, he thought it necessary to take away part of the area which the London Company were then supplying. The Metropolitan having agreed with the Marylebone people, he thought it necessary to leave that parish to the Metropolitan. He had it before him that the London was supplying in Marylebone and in St. James's very largely by means of overhead wires. He thought it was very desirable that overhead wires should be abolished, and therefore, having left Marylebone to the Metropolitan, he allotted St. James's to the London, putting them under the obligation to remove the whole of their overhead wires within a certain time. He did not think it would be within the powers of the Board of Trade to grant a mere way-leave through a parish; and that was one reason he had for recommending the Board to schedule compulsory streets. He did not think it desirable that a part of a district should be used simply as a means of getting to another; any company going through a parish should be put under an obligation to supply. He thought there should be continuity of area, and that was one reason for giving the united parishes of St. Margaret's and St. John's to the London. Another was that the London had their generating station south of the Thames. They could get across, it was perfectly true, by agreement with the railway company, but he thought it better that they should have an alternative route by which they could reach their district on this side of the Thames, without being absolutely dependent upon agreements with the railway companies. On a railway, for instance, the route might be broken by a run off.

Cross-examined by Mr. BIDDER, Q.C.: You have acted under the belief that the Board of Trade had no power to grant to an electric light company a way-leave through a district which is not part of their own district?—I believe that they have only power to grant leave to break up streets in the area of supply; and apart from that I consider that where they do come through they should be put under obligations.

That is implied in what you say in your report: "It is in the case of St. Mary, Lambeth, essential to the continuity of the London Company's area that this company should have the means of passing through the northern end of the parish." If, in fact, a company submits a scheme to you which has a generating station at one end of London and the district of supply at the other, in order to effectuate their wishes you feel it necessary to give them all the intervening district, or at least so much as will enable them to lay their pipes along?—I do not admit that is quite the case. They had a very large district to get to, and it is a very small piece it goes through.

The principle on which you dealt with this company was that Deptford Generating Station being down the river, and the place to be aimed at being in the neighbourhood of Chelsea and so on, it was necessary to put them in those intermediate districts of Bermondsey, Rotherhithe, and so on, to enable them to find a road?—No, the districts of Bermondsey, Rotherhithe, and so on, as you put it, wished to have them; as did also the district of St. George's, Hanover-square. Those districts which wanted to have them formed a very large proportion of the district of supply. A much smaller proportion did not consent to their coming through. If the northern part of the parish of Lambeth had not intervened between the districts which wanted to have this company I would not have put it in. Two districts have been added to the area of this company to make the area continuous.

You might have acted on another principle; this company, being essentially a company contemplating a generating station on the south side of the river, might just as well have confined their operations to the south side of the river?—No; I do not think so, because they were actually supplying a very large proportion of the north side of the river at the time.

You say there ought to be two companies everywhere?—No; I think it is desirable that there should be two companies. I think competition is desirable, but I do not say everywhere. I have stated in my report that where the local authority did not wish to have a company in, then I thought only one should be allowed in.

As a matter of fact the local authority of St. James's appeared before you protesting against the second company coming in?—They appeared before me to oppose. At the same time the representative of the vestries said that provided they would consent to come in on the same terms as the other company he would let them come in. The reason for that, as given in his evidence, was that they were already supplying largely in the parish. The Vestry said that they would rather have the Metropolitan.

You stated that the Metropolitan had agreed with Marylebone, so that it was necessary to turn out the London?—No; in districting between the two they were to allot Marylebone to the Metropolitan.

Your reason for not turning the London out of St. James's is that they have got overhead wires, which you regard as a nuisance, and you do not turn them out in order to be in a position to get rid of overhead wires?—I thought you could not fairly insist upon their not taking down the whole of their overhead wires if we took their whole business away from them.

You are aware that by the Act of last year the consent of the Vestry was necessary unless the Board of Trade thought it should be dispensed with, and in such cases should make a special report?—Yes.

A discussion arose as to the special report, Mr. BIDDER contending that the report required by the Act to be made by the 1st of July was the special report; but it was pointed out to him by the Chairman that the report was described in the margin of the Act as the annual report.

Major MARINDIN remarked that he was not responsible for the dates, but he knew that there was a tremendous hurry through the whole thing to get it through in time.

Mr. BIDDER (to witness): I do not know whether you expressed your opinion as to the relative advantages of the continuous current or the alternating current?—I am not a scientific electrician. As to the details of it, I express in my report what the advantages of the two systems are.

You express in rather positive language what appear to be the disadvantages of the high pressure alternating system?—That is not mine, but Major Cardew's, my assessor. I quite agree with it.

Are you strongly in favour of the continuous system?—I think from the consumers' point of view there is no system which gives so good a supply as the direct current and storage batteries.

Is not that the continuous system?—The evidence before me was to the effect that over a large area the transformer system had great advantages, and I thought both were good. I should prefer not the continuous system quite as supplied by, I think, the St. James's and the Pall Mall, but as supplied by the Chelsea Company, where they supply entirely by the storage batteries. That is the one which I believe is the best.

None of the other districts are comparable in area with that of the London Company?—The acreage of the Metropolitan area and of the London area were not at one time very different; but the Metropolitan have since

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dropped a large part, and so the area of the London is very much larger than that of any other.

Why are two years given to the London Company, whereas the Board of Trade insisted that the St. James's and Pall Mall should have one year?—I think there is a little difference in the two cases. The St. James's and the Pall Mall are in this position—that they are not called upon to supply anybody until after one year. Then you may be requisitioned, but you have no compulsory streets.

Why have the other company two years for the same thing?—The London Company are bound under two years to lay their mains over certain scheduled streets, and they are bound after 18 months to supply any other streets to requisition.

Why should not they come within the same obligations as the St. James's and Pall Mall do?—Eighteen months was thought fair all over London.

A discussion again arose as to the special report required by the Board of Trade.

On Mr. GRAY rising to speak on behalf of the Board,

Mr. LITTLER objected to anybody appearing for the Board of Trade, on the ground that they were neither in the position of promoters nor of opponents.

Mr. BIDDER also supported this contention, observing that no department of the Executive Government had any right to intervene between the petitioners and the parties to Bills before the Legislature.

The point having been argued, the room was cleared, and after spending some time in deliberation,

The CHAIRMAN announced that the Committee considered the point of so much importance that they would give their decision to-morrow.

The Committee then adjourned.

WEDNESDAY, AUG. 7.

On resuming this morning, the CHAIRMAN said that he understood that the application by the Board of Trade to appear by counsel had been withdrawn, and there was no necessity for the particular ruling.

Mr. GRAY said that the position of the Board of Trade was entirely neutral, and he was there merely to assist the Committee in any matter that might arise.

Major MARINDIN was then examined by the CHAIRMAN on his report on the Electric Lighting Orders. Asked as to the scope of the inquiry, Major Marindin replied that there were applications sent in from a large number of companies with different areas, and he had to determine more particularly what areas should be allotted to each company, and whether it was desirable that there should be more than one company in any particular area, and to decide generally as to whether it was desirable to adopt the system of districting altogether or to have competitive areas.

Was the inquiry a general one to consider the lighting of the metropolis generally, or only to consider the applications of certain companies?—It was in reference to the areas applied for by the different companies who sent in applications. It did not apply to any part of the parish outside of the area applied for. The Board of Trade wished to adopt a general scheme of electric lighting, and they wished to have guidance as to the best way of drafting the different orders, with the view of having them identical. I also inquired into the financial condition of the companies to a certain extent. The greater part of the inquiry was directed towards the advantages and disadvantages of the different systems, and a great deal of scientific evidence was given. I was quite satisfied that the whole of the systems which were advocated were practicable and worthy of a trial, without saying which exactly was the best system—in fact, I do not think anyone can say which is the best. None of the companies are tied to any system; they might adopt any system they pleased.

Did you consider that any of the systems proposed were dangerous?—Not with proper precautions.

Mr. POPE said with the exception of this Order no other Order would raise a preamble question at all. The sole question upon the subsequent Orders was with reference to the County Council requiring a clause about bridges which it was proposed to go over, and in this the Metropolitan Supply Company (for whom he appeared) had agreed with the County Council.

Mr. BATTEN said he wished to ask Major Marindin a very important question, viz., whether it was brought to his knowledge that the £100 Founders' Shares in the Westminster Company were to be £2,500 if this Order passed?

Mr. WALLACE: That is not so.

Major MARINDIN: There was nothing in the evidence about that. Evidence was given as to what the company was, and there was only a small sum subscribed.

Mr. BATTEN: Was it brought to your knowledge that the first founder who subscribed the first £500 was to have one-fourth of the entire profits of the sale of this undertaking if the Bill was sold to the adjoining company?

Mr. WALLACE: That is not so.

Mr. BATTEN (to Major Marindin): But at any rate the fact disclosed in the Memorandum of Association of the Westminster Company was not brought under your notice—that the founders were to have £2,500 for every £100 subscribed?—No.

Mr. HARRY WILKINS, the vestry clerk of St. James's, Westminster, was called, and stated that his vestry was in favour of limited competition at the present time between the direct and alternating systems. They originally opposed the London Company, but most of their objections to it had been removed, and they did not now object.

In cross-examination by Mr. MUIRHEAD, WITNESS said that they were waiting to see whether the direct or alternating current was the best, and until this was worked out by actual practice they preferred competing systems.

Asked if the St. James's would be able to supply all the wants of the parish in the event of the Provisional Orders not passing, WITNESS said that at present the St. James's had only got power over the southern portion of the parish.

Mr. PEMBER said that the Westminster Electrical Syndicate and the London Electric Supply Corporation had agreed not to oppose each other in the event of the former applying for a license.

Mr. BATTEN: That will answer our purpose.

The first witness called was Mr. BALFOUR, who, in answer to Mr. MUIRHEAD, said that he was Chairman of the St. James's and Pall Mall Electric Lighting Company. Witness was going into the detailed working of the Company, when

Mr. PEMBER said that he did not propose to ask any question as to the financial ability of the Company to do this work, but his learned friend wanted to make it a serious question as to this Company's mode of lighting.

Mr. MUIRHEAD then examined Mr. BALFOUR as to what he thought of a second company laying their mains alongside his Company's mains?—Witness said that it would be extremely difficult for them to do it, and it would be extremely inconvenient for people to have the streets up twice.

Mr. POPE: Perhaps you would like an absolute monopoly?

WITNESS: Well, we have got our license, and we are working satisfactorily. I think before an expensive competition were introduced it would be only fair to go on for another year or two, and then if we were found not to be working satisfactorily competition should be permitted. If competition is to go into a district like that it would be more difficult for the Companies competing to furnish the public at a moderate rate, because the amount of money they have to spend in laying duplicate mains is about double what one company alone would do. Besides that, there was the question of supplying energy to motors, and there it would be unreasonable, because we are the only people supplying energy. We say that our Company should have a fair chance of carrying on their work, and in the event of our not supplying the parish properly another company should be allowed to come in.

Mr. JAMES SWINBURN was next examined by Mr. BIDDER. Witness said that he was an electrical engineer with a large practical experience, and was acquainted with the system of the St. James's Lighting Company. It was a well-known system. The license was only obtained in 1888, and the works were in progress at the present time, and the best known means of supply would be at the command of everybody in that district. He thought it would be exceedingly hard for another company to come in at the present time. There was this distinction between the St. James's and the London—that the former was under a license for seven years, and if the latter got their Provisional Order it would be for 42 years, so that the two would be competing upon unequal terms. The larger the supply the cheaper they would be able to produce electricity. It depended very much upon the length of the mains. In the London Company's Order there were certain streets in which they were to be compelled to lay down mains specified in the second schedule to the Order, and these streets were the cream of the district.

With regard to the continuous-current and the alternating systems, which is the best?—I think it is very generally acknowledged by all electrical engineers that the alternating system is best for districts where the lighting is scattered; and the direct current is suitable in districts, like the St. James's, where all the lights are close together. With a low-tension current there was a considerable loss in carrying the current for a long distance, and that was diminished by the adoption of the high-tension alternating system, and it became almost in ignificant. With the alternating system they had to use more lamps. Storage batteries would be used here, and that meant extra safety against breakdowns. With the alternating system you have to depend upon duplicate machinery for security against breakdowns. Many of the streets were very narrow, and it was of importance that culverts should not be interfered with in digging.

LORD CRAWFORD said that they had a motor, what do you say to that?—There is nothing new in it, and no appreciable advance is known. American companies have wanted to use motors for a long time; and it is very important to the Westinghouse and Thomson-Houston systems, and they would have brought it into use if it had been practicable.

Cross-examined by Mr. PEMBER as to the evidence of Sir Wm. Thomson before Major Marindin, wherein Sir William stated that for large central lighting large engines were the best for reserve power, and for small domestic lighting in isolated cases storage batteries were very valuable, witness said that if he could only have one engine he would prefer the batteries.

Mr. BIDDER then addressed the Committee. He said that he would not ask them to throw out the Order, but to exclude that particular district of the St. James's from the district assigned to the London Company under the Order. The other parts of the Order he had nothing whatever to say to. The principle had been well recognised in the Act of 1888 and otherwise, that the giving to one company of a Provisional Order to supply particular districts was not to give them a monopoly, but that Parliament should consider whether it was reasonable that another company should come there. He submitted that it was not reasonable that the London Company should be allowed to come into the St. James's district. In the first place, in including St. James's district in the London Provisional Order the Board of Trade had not acted under the powers conferred upon them. They were expressly forbidden from granting an Order in the district of any local authority without the consent of that local authority, unless they made a special report stating the ground upon which they had dispensed with such a thing.

The CHAIRMAN: Does the learned counsel seriously contend that this special report is necessary?

Mr. BIDDER: Certainly.

The room having been cleared, the Committee deliberated, and

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The CHAIRMAN said that the time had elapsed for considering whether a special report was necessary or not, and it ought to have been raised at an earlier period.

Mr. BIDDER quoted Major Marindin's report to show that the inclusion of the St. James's district in the Order of which his company complained was really a consideration given to the London Company for requiring them to remove their existing overhead wires. The removal of overhead wires might be a very desirable thing, but he protested against the London Company being introduced into the St. James's district in order to have them removed. Another reason for excluding the London Company from St. James's was that they were getting nearly half of the whole of the Metropolis, or a population of something like two millions. The district was far larger than the existing capital of the London could carry on the works with, and something like double the capital would be required to supply the whole of their districts. Their lordships would be doing less injury to the London in saying that they should not go into the St. James's district, seeing that they had got a much larger district already than would employ the whole of their capital. In the course of three or four years circumstances might arise by which the local authority would think it desirable to give its consent to a second company to come to Parliament to supply the St. James's district. He therefore asked the Committee to strike St. James's out of the present Order.

Mr. PEMBER, in reply, said that the London Company had taken all kinds of districts, good, bad and indifferent, whereas the St James's Company had selected this specially good part of the Metropolis only. The capital of the London Company was £1,250,000, of which over £800,000 had been already subscribed, and £500,000 spent. It was only when these companies were conducted on a large scale that they could be remuuerative. Then Mr. Bidder had told them that the London Company had been allotted nearly half the Metropolis ; but that was not accurate. There was not a single parish on the north of the Thames, except Clerkenwell, where they were not in competition with other companies ; and on the south of the Thames they had a vast deal which was not remunerative, as in Bermondsey and Rotherhithe where no other company would go. As to the consent of the vestry not having been given, they had had the clerk of the vestry (Mr. Wilkins) who was deputed to say that the vestry did consent. These large companies must have large areas, and the good part of their area must be taken to pay for the bad. Major Marindin had decided that competition was a wise thing, and that it should be a competition between alternating currents and direct currents. Then both systems would be on their trial. People would have a chance of taking their supply from the one or the other, and by that means they would have the most advantageous competition, and the different systems would have full scope.

The room was cleared for the Committee to deliberate. On the public being re-admitted,

The CHAIRMAN said : The Committee will proceed to the consideration of clauses so far as the London Order is concerned.

Mr. BIDDER : Does that mean that you have decided against me ?

The CHAIRMAN : Certainly. We will now proceed with the London clauses, as we understand that those clauses will govern the other Orders.

The clauses of the London Company were then discussed.

Mr. FREEMAN (on behalf of the County Council) then brought up a new clause as to bridges of the London County Council, which after considerable discussion was adopted as follows :—

"Whereas Westminster Bridge is the only bridge across the River Thames within the area of supply, therefore, for the purpose of laying a main or mains across the said bridge and the approaches thereto, so far as they are vested in the County Council, the Undertakers may exercise the following powers, and shall be subject to the following conditions :—(1). The Undertakers shall be entitled to use for laying such main or mains a space either under the carriage-way or the foot-way of the said bridge and approaches, or partly under the carriage-way and partly under the foot-way, not exceeding in sectional area the area contained within the dimensions of sixteen inches wide and eight inches deep in such position as the Council may prescribe. (2). If the Council find that a space of sixteen inches wide by eight inches deep cannot be used for this purpose without undue interference with the fabric of the bridge or the carriage-way or foot-way thereof, then the Undertakers shall be entitled to use a space or spaces sufficient in aggregate sectional area to admit eight mains each of dimensions (including any cover) of not exceeding four inches square, such mains being placed either together or separate in such position as the Council may prescribe. (3). If the Undertakers require any greater space than that hereinbefore specified, nothing herein contained shall prevent the Council from authorising by consent in writing the use of such greater space as can be afforded without undue interference with the said fabric carriage-way or foot-way. (4). The Undertakers shall not break up or interfere with any part of the said bridge or the approaches thereto, or the road-way or foot-way over the same except in accordance with plans, sections, and particulars previously submitted to and approved in writing by the said Council or as may be settled by arbitration as hereinafter provided. (5). If within 28 days after the submission of such plans, sections, and particulars to the said Council, with notice in writing requiring them to approve the same, the said Council shall disapprove or fail to approve such plans, sections, and particulars, then such plans, sections, and particulars shall be referred to an arbitrator to be appointed by the Board of Trade on the application of either the said Council or the Undertakers. (6). Such arbitrator shall consider and determine, having regard to the structure and design of the bridge, and to the provisions of this section and all other circumstances of the case, on what terms and conditions and in accordance with what plans, sections and particulars such main or mains shall be laid across the said bridge and approaches subject to the provisions of this section ; and the Undertakers shall be bound to comply with and observe all the terms and conditions imposed, and the plans, sections and particulars approved by such arbitrator. (7). The Undertakers may, if so required in writing by the County Council (instead of breaking up or interfering with the said bridge or any part thereof), place their main or mains wholly or in part along and on the outside of the said bridge in such position and with such covering as may be prescribed by the County Council."

After some verbal amendments the Order was passed.

Mr. SAUNDERS, Q.C., briefly opened the Westminster Electric Supply Corporation Order, and the Committee adjourned.

THURSDAY, AUGUST 8TH, 1889.

The Committee, after hearing evidence, confirmed the Order granted by the Board of Trade to the Westminster Electric Supply Corporation. The Order was unsuccessfully opposed by the City of Westminster Electrical Syndicate, and their application for a clause preventing the Corporation from opposing them on grounds of competition if they applied for a License or Provisional Order was refused. Westminster, Lambeth, Vauxhall and Chelsea Bridges were, by arrangement with the County Council, excluded from the area of supply.

[*A full report of Thursday's proceedings will appear in our next issue.*]

THE VESTRY OF ST. JAMES, WESTMINSTER, AND THE ELECTRIC LIGHTING ORDERS.

The Vestry of St. James has directed their Clerk to address a letter to the Board of Trade, of which the following extract covers the most important clauses :—

"I am in the first place to remind the Board that in the metropolis the vestries and District Boards of Works are the Local Authorities, except as regards streets which were lighted by the Metropolitan Board of Works, and that it is to these last-mentioned streets alone the jurisdiction of the London County Council, as successors in law to the Metropolitan Board of Works, appears to extend under the Electric Lighting Acts.

Both the Model Form of Order issued by the Board, and the filled up Order, were submitted to the Vestry at so late a period of the Session as to preclude careful consideration in detail. I am, however, to point out that the 13th clause of the London Company's Order, taken in conjunction with the interpretation of the expression "County Council" in Clause 2, would appear to give the Council concurrent jurisdiction with the Vestry over the breaking up of streets which are vested solely in the latter. The Vestry are of opinion that the duties of the County Council under this clause should have been clearly limited to streets, bridges, &c., under their control, and to cases where any proposed works were likely to interfere with any sewer, or other work, vested in the Council.

The 12th Clause of the Order confers upon the Council powers with regard to overhead wires, which, by the principal Act, are expressly reserved to the local authorities ; and as the Order is made subject in all respects to the principal Act, it would seem that the Council and the local authority will, in this particular also, have concurrent jurisdiction under the Order. I need scarcely point out that the possession of concurrent jurisdiction involves the possibility of conflict between a central and local authority, which may be followed by very regretable results.

I am further to submit that, in view of the expressed intention of the Government to transfer to the Council powers under the Electric Lighting Acts now vested in the Board of Trade, it is highly undesirable that the Council should also be vested with powers at present exercised by the Local Authorities under statute. If the Council were constituted the Local Authority as well as the controlling department, they would be placed in the illogical position of being an appellate tribunal against their own decisions, and in some cases would be called upon to appoint an arbitrator to decide between themselves and the Undertakers, a proceeding calculated to deprive the award of the arbitrator of much of its value.

The Vestry regret that further time was not allowed them for considering the new provisions embodied in the Model and in the filled up Order, before the latter was submitted to Parliament for confirmation, and this regret is deepened by a feeling that it is futile to ask Parliament, at so late a period of the Session, to virtually recast the Order in some material respects. The Vestry trust, however, that the considerations which they now venture to urge may receive due weight when the Board are next called upon to frame an Order relating to the metropolis."

Telephone for the Madras Harbour Works. — The local Government indented some time ago for a telephone apparatus for the Madras Harbour Works, but were informed by the Home Government that they had not complied with the indent as an air speaking-tube was considered better by the Admiralty. The local Government, however, ventured the differ with the Admiralty, and insisted on having a telephone for the divers, as the air tube had often been tried on the works and found useless, on account of the waves, extra piping and continual knocking together of the several tubes, which rendered it impossible to hear anything, besides having to stop the pumps.

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LIGHTNING CONDUCTORS.

The *Journal* of the Institution of Electrical Engineers containing the report of the discussion on Dr. LODGE'S Paper on Lightning is now in the hands of the members, and it may therefore not be out of place to review the subject here. Dr. LODGE'S communicated reply will be found in another column. We are a little apt to look upon the whole as a very interesting and perhaps somewhat amusing discussion between the disciples of the old lightning-conductor theories and the more modern; but it must be borne in mind that it is not a question of merely theoretical importance, or of passing interest, but one on which hangs, at any moment, lives of fellow creatures and the safety of enormous property. The earlier investigators either omitted self-induction from their calculations altogether or absurdly underestimated its importance. Within the last few years the study of self-induction in all branches of electric science and practice has been eagerly followed, and the various methods of measuring it became at one time quite a fashionable, though, perhaps, rather useless hobby. Dr. LODGE tackles the question fully armed with all the most recent knowledge relative to Leyden jar discharges, thereby being enabled to see farther than the great men of old. As he frankly says, anyone else *might* have done the same thing; but the difference between Dr. LODGE and other people is that he did and other people did not. No one reasonably conversant with the science can deny that the discharge of a Leyden jar through a comparatively small resistance is oscillatory. Obviously, if there were no dissipation of energy by resistance (and by radiation) the oscillations would go on for ever; if the resistance is increased till the energy lost on it in discharge is equal to the whole energy of the charge there will be no oscillations. We do not quite follow Dr. LODGE'S calculations as to the self-induction of his air condenser. The self-induction of a conductor whose ends are not

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coincident is an unthinkable sort of thing. One, therefore, naturally thinks of the return current, which is, in this case, the electrical displacement between the plates. If this is assumed normal to the surface of two discs, the self-induction comes out the same order of figure as Dr. LODGE's, except when the condenser-plates are exceedingly close together; in fact, it does not much matter where the return displacement is assumed if the conductor carrying the discharge itself is comparatively small. Dr. LODGE assumes that it is exceedingly small, even in the case of a lightning flash. The electric resistance of a wire of blue hot air, one millimetre in diameter, is probably exceedingly small. Air in the inside of incandescent lamps conducts pretty freely as soon as the carbon gets to a white heat, and the heating due to a lightning flash would rarefy the air in its path, and heat it to such a temperature that its resistance might be surprisingly small. The mutual induction of the parts of the stream would make the current flow on the outside of the hot air wire; in fact we might speculate as to whether a lightning flash is not conveyed by a tube of conducting air. This would, on the other hand, increase the resistance of the air-wire. In fact, the resistance would depend on the vibration frequency, which complicates the problem considerably.

The full appreciation of the effects of self-induction is not the only novelty in Dr. LODGE's treatment of the subject; he draws a clear distinction between prepared and sudden impulsive rush discharges. We believe this is new. Of course there was the old striking by induction. This was not very clearly defined. In 1871 or 1872, Prof. PERRY, lecturing on lightning at Clifton College, killed a mouse who was waiting for some subsequent experiments upon him. The mouse was supposed to have been killed by the sudden dissipation of the charge induced on his back by a conductor connected with a Leyden jar with which the learned professor was experimenting, and this is, we think, what was known as killing by induction—at least so we remember Prof. PERRY's interpretation. Is it not, however, more likely that death ensued owing to an oscillatory discharge surging to and fro and spitting off from some neighbouring conductor?

We do not think Dr. LODGE very clearly explained what he meant by the path being prepared or unprepared in the two cases. It is not very clear why an unprepared path should not prepare itself instantly so as not to differ in effect from a prepared path. If the path consists partly of dielectric and partly of conductor, in the prepared case we can imagine that the point of the conductor would be charged and the whole stress would be supported by the dielectric up to the instant of the flash. In the sudden rush case, self-induction might prevent the instantaneous charging, so that the flash would take the path in which the initial insulation per centimetre could be broken down most easily. But this is somewhat vague.

It is strange that, though during the discussion many people objected to a tin plate being taken as representing a cloud, no one found fault with the relative proportions of dielectric and metallic conductors in the circuit. A Leyden jar, or a tin cloud discharging through a few inches of air, is not the same as when discharging through the air with a foot or many feet of metallic conductor in series. In most of the experiments this is not to the point, but we cannot help wondering whether Dr. LODGE has not forgotten the relative lengths in the case of lightning. Given a lightning flash. A certain amount of energy is to be dissipated with as little danger to life and property as possible. If resistance is inserted to damp the oscillations, and that resistance is confined to a very small fraction of the length of the spark, surely in the first place the expenditure of energy is concentrated where it is not wanted, and a difference of potential is produced between the ends of the conductor, due to resistance, which in conjunction with the self-induction effect may tempt the lightning to break down another path for itself. Of course, once the lightning has broken down the insulation of its path through the air, the resistance of that path is so low that it may not care to leave it.

It may, perhaps, be worth while to remark that the oscillatory discharge must not be confused with the multiple flashes visible to the eye in the case of lightning. It is even difficult to see how the oscillatory discharge, whose period may be comparable to one-millionth of a second, could be made visible by a revolving mirror, as the conducting air would remain practically equally incandescent all the time. If the oscillations are visible in a mirror this might prove that the light of a flash is not due to the incandescence of the air. The repetition of lightning flashes may be observed by borrowing a watch and removing the balance wheel, and then counting the apparent number of seconds hands made visible by the light of the lightning flash while the wheels are whizzing round. This may show that cloud is a bad conductor. If a flash discharges a small surface of cloud, leaving the rest charged, the charge would take some time to equalise itself. The discharged part would charge up; but long before it got to its old point it would discharge again, as there would be a path of comparatively hot air ready for it to break open. It would seem highly probable that if the cloud is a bad conductor—in fact, its badness is obviously a matter of degree—an oscillatory flash must itself take down a greater charge than a single one. The patch of cloud first discharges, and over discharges. This makes the charge of the rest of the cloud rush in to fill the vacancy. The charge, less the part lost due to resistance and radiation, comes back, but does not force the newly-arrived or usurping charge back with the same force as the negative charge urged it in, so that on second discharge, or rather second oscillation, there is a greater discharge than if the patch of cloud had been insulated from the rest.

The result of the discussion is roughly that we do not know anything to speak of about lightning conductors. This is really infinitely better than being saturated with absurdly erroneous ideas. In the meantime we do not quite know how to be secure. We notice that Dr. LODGE has patented a lightning conductor which is to prove our salvation, and we earnestly hope it will soon be in the market.

REVIEWS.

The Mutual Electric Manufacturing Company.

We have received from the Mutual Electric Manufacturing Company of Brooklyn, N.Y., an elaborate circular of some 30 pages, giving in a popular form an account of the particular system worked by them. This publication—which we may remark *en passant* bears a great similarity both externally and internally to the magnificent catalogue issued some months ago by the Westinghouse Company, and alluded to in *The Electrician* of December 7th and 14th, 1888—would be much improved if the fine cuts which illustrate it were placed opposite the matter referring to them instead of being, as at present, arranged in a somewhat haphazard fashion. The patents owned by the Mutual Company are those of their chief electrician, Mr. E. R. Knowles, and embrace amongst other things a dynamo, an arc lamp, an automatic regulator, a meter, and a storage battery. The system of distribution devised by Mr. Knowles merely consists in supplying from one set of dynamos and by the same conductor both arc and incandescent lamps. This is effected by means of storage batteries arranged in sub-stations, and charged during the daytime with a constant current of 15 amperes. When the arc lights are required the batteries are cut out. Each lamp and

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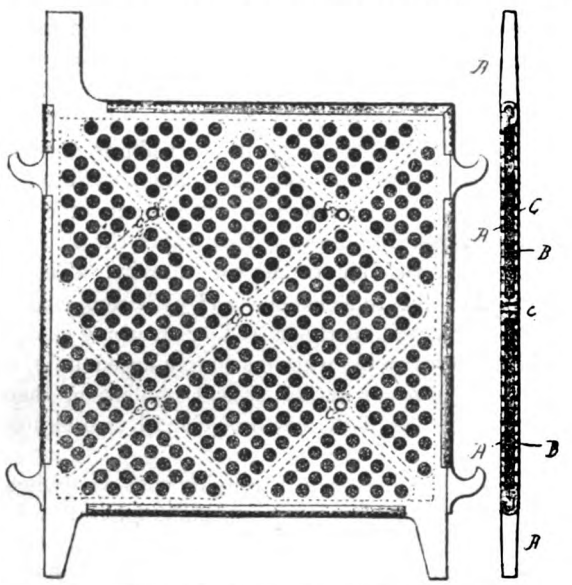
set of batteries is furnished with an automatic polarised cut-out, those on the arc lamps operating when the current is in one direction and those on the batteries operating when the current is reversed. The Knowles' automatic current-regulator is of two types, one shifting the brushes on the dynamo commutator and the other switching resistances in or out of circuit. In both types the regulator consists of a nest of gear-wheels, which are revolved in one direction or the other by the action of an armature suspended between two electro-magnets, one of which is energised when the current exceeds the normal, and the other when the current falls below it. In the Knowles' meter, which is of the clockwork type, the movements of the core of a solenoid under the influence of the current actuate a pointer. The end of this pointer is in close proximity to a drum, which is revolved at stated intervals by clockwork. On the drum are arranged a number of longitudinal ribs or teeth of different lengths; consequently when it revolves, more or less teeth come into contact with the pointer, according as the latter is nearer one end or the other of the drum. Whenever the pointer makes contact with one of the teeth on the rotating drum it closes the circuit of an electro-magnet actuating a set of dials on which the ampere-hours are finally recorded. The plates of the Knowles' storage battery (*see* figure) which, accord-



The Knowles Storage Cell Plate.

ing to the catalogue, "will *never buckle* or twist under proper handling," which never sulphate, and whose active material will not fall out, consist of two halves, A A and B B, bound together by rivets at the points C C, and between which the active material is placed in the form of a sheet, the enclosing plates being perforated to give the electrolyte access to the active material. The plates are cast of an inoxidisable alloy, which is said to contain no mercury. The Knowles' system, it will thus be seen, contains several novel features, and although we are unable to endorse all the superlatives in the catalogue, there can be but little doubt as to the ingenuity displayed by the chief electrician to the Mutual Electric Manufacturing Company.

Applications Industrielles des résidus provenant des Piles aux Bichromates. By G. Fournier. (Paris: Bernard Zignol, 1889.)

The utilisation or reconversion of the residual products of the bichromate cell was for a long time reckoned amongst the chief desiderata of electricians, and many were the attempts to solve the problem. Even to-day, notwithstanding the enormously increased facilities for obtaining electrical energy, we must still admit that the question maintains a certain importance, and we therefore welcome this little brochure of M. Fournier as affording the opportunity of reviewing the last word which chemical science has had to say upon the subject. The author is contented to point out by what processes certain saleable materials may be obtained, and he necessarily leaves the question of commercial availability for local consideration, when the cost of collection, manipulation, &c., can be taken into account.

M. Fournier's method of operation does not seek the regeneration of the solution, but, as we have intimated, the extraction of saleable products. These are "chrome alum," potassic or sodic sulphate, chromate of zinc, and chromic acid.

The spent liquid from the cells will contain the sulphates of potassium (or sodium), of chromium, and of zinc, together with chromic and sulphuric acids. The first operation is to add granulated zinc until the acid has been neutralised. This done, if the *potassic* bichromate has been employed, we shall find a deposit of crystals of "chrome alum" (the double sulphate of chromium and sodium), which salt has a market value as a mordant for use in dye-works. If the soda salt is used we do not get this deposit, the double sulphate of soda and chromium being highly soluble.

The next operation is to extract the chromic oxide. For this purpose more zinc is added, and the solution is heated to 100° C. The chromium is precipitated in the form of oxide, and the solution contains only the sulphates of zinc and of potassium or sodium, as the case may be. To this solution is added "milk of lime," which precipitates the zinc oxide, and the remaining potassic or sodic sulphate may be drawn off, and after evaporation is ready for sale.

The mixed precipitate of sulphate of lime and oxide of zinc is next freed from excess of lime by the gradual addition of a solution of zinc sulphate. To the liquid thus obtained a solution of bichromate of potassium is added, producing a precipitate of yellow zinc chromate, for which a ready market may be found. The liquid remaining contains only potassic sulphate, and is of course added to the solution previously obtained.

We return now to the chromic oxide, which readily yields dye materials of some value. By calcination we obtain a fine shade of green, and various shades of the same colour are obtained by combination with boric, picric, and some other acids. Or by dissolving in dilute sulphuric acid we obtain a valuable mordant. Lastly, we can prepare chromic acid by calcining the oxide with a mixture of carbonate of lime and quicklime, and treating the product with dilute sulphuric acid. The process, however, requires to be carried out with special precautions which we have not space to enumerate.

It will be understood that we have not attempted to more than briefly indicate the general character of the operations proposed by M. Fournier, and to those who are especially interested in the chemistry of the bichromate cell, and still more to any who, not being competent chemists, may feel tempted to try the experiments described, we strongly recommend a perusal of the original work. We must add, in conclusion, that some alternative methods of treatment are given which we have left wholly unmentioned.

Practical Electric Bell Fitting. By F. C. Allsop. (E. and F. Spon. London, 1889.)

The present volume, which is a reprint of some articles which originally appeared in the columns of the *English Mechanic*, is the third or fourth publication dealing with electric bell fittings that has come under our notice during the last few months. It is a good practical treatise upon a subject which demands only the most elementary knowledge either of electricity or mechanics. The volume consists of some 140 pages, and is adorned with nearly 150 illustrations; it is written in simple, straightforward language, and will doubtless prove of the greatest service to the class for whom it is intended.

BOOKS, &c., RECEIVED.

"The Tabor Indicator." John Musgrave and Sons (Limited), Globe Iron Works, Bolton.

"Proceedings of the Academy of Natural Sciences of Philadelphia." Part I. January—April, 1889. (Philadelphia.)

"Useful Rules and Tables relating to Mensuration, Engineering, Structures, and Machines." By W. J. M. Rankine. Seventh Edition, thoroughly revised by W. J. Millar, C.E. (London: Charles Griffin and Co.)

"Incandescent Wiring Handbook." By F. B. Badt. (Chicago: Electrician Publishing Company.)

"Die Allgemeine Elektricitäts-Gesellschaft auf der Deutschen Allgemeinen Ausstellung für Unfallverhütung in Berlin."

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THE BIRMINGHAM EXHIBITION.

From a technical point of view the Birmingham Electrical Exhibition is likely to be memorable for the excellence and the representative character of the display by well-known firms of their well-known manufactures, rather than for the number or the importance of the novelties displayed. That it will prove a great attraction to the public is unquestionable, and that it will also repay a visit from the members of the profession cannot be gainsaid; but, so far as is at present discoverable, there will not be many important exhibits with which our readers have not already had an opportunity of becoming more or less acquainted. Such being the case we may pass by some features of the show which will loom most largely in the public gaze with comparatively brief mention, and reserve our space chiefly for detailed descriptions of appliances which are not at present so familiar to the electrical world. In this preliminary article we content ourselves with little more than a general survey of the leading features.

Considering that Bingley Hall was only placed at the disposal of the Executive Committee a fortnight before the day fixed for the opening ceremony, the state of preparedness which the Exhibition now presents is on the whole very creditable to the responsible officials. It is, however, somewhat unfortunate that with the exception of the lighting, which is nearly complete, the electrical exhibits are in most instances in a backward state; and it is this, doubtless, which gives the impression that the industrial portion of the Exhibition to some extent overshadows the electrical. The Machinery Hall and heavy electrical exhibits will, however, be complete in the course of the next few days, when the electrical character of the Exhibition will no doubt reveal itself more prominently. Meanwhile the space allotted to some of the most important firms is still vacant, and the stands of many others are as yet incomplete.

The arc lighting is throughout excellent and ample, and the incandescent lighting, although at present of somewhat modest dimensions, is very satisfactory. The Anglo-American Brush Corporation light a bay of the main building with eight 2,000 candle-power Brush arcs. These lamps are run in parallel off a Mordey transformer at 100 volts, each lamp having an impedance coil in series with it. The current is supplied by a 2,000-volt Mordey alternator, rope driven by a Brush vertical compound engine. This machine (Fig. 1) is one of the same size as those which were recently run in parallel, and as alternate-current motors, in the works of the Corporation. The normal speed of the machine is 650 revolutions, and the output 37,500 watts, or 50 electrical horse-power as generator, or 50 horse-power as alternate-current motor. The excitation of this machine is comparatively small; 500 watts are required for this purpose at full load, and rather less with lighter loads. One point worthy of notice in this dynamo is the very small waste of power that takes place when the machine is run on open circuit or with a small output. When excited to give the full electromotive force at the full speed, but with no external load, it requires only 3 horse-power. This is an important point, as it is sometimes necessary to run alternators for a considerable portion of the day with a very small load indeed, and it is therefore desirable that when so running the absorption of power should be as small as possible. The commercial efficiency of the machine with full load is fully 90 per cent. There are some differences in details when compared with the first machine of this type which we described in our columns about a year ago (*The Electrician*, May 25, 1888, p. 81), the modifications being such as to add to the mechanical stability of the machine. The copper sheath which was previously used to cover the revolving magnet for the prevention of disturbance of the air, has been replaced by an iron sheath cast in one with the magnet itself. The exciter is of the ordinary type Victoria machine, and for convenience is mounted directly on the shaft. The exciter shown in the figure is a larger one than is required for exciting the alternator, being, in fact capable of exciting two such machines. The same alternator also supplies current to another 24-kilowatt Mordey alternator running as a motor, which in turn drives an E_2 "Victoria" dynamo, supplying three 5-ampere arcs and a number of incandescents. The lighting undertaken by Messrs. Fowler, Lancaster and Co., who employ Thomson-Houston plant, will comprise when completed forty 2,000 arcs—twenty-four in the main building, six in the winter garden, and ten in the streets outside the Exhibition. These lamps are run off two 35-light dynamos, belt driven off an 80 horse-power Armington and Sims engine. Mr. A. A. Goldston, of Middlesborough, lights the Machinery Hall with five remarkably steady 2,000 candle-power Brush lamps; he also has eight lamps in the main building, and two in the boiler-room. These lamps are run off a 25-light Brush machine, belt driven by a 10 horse power nominal high-speed Robey engine. This circuit is run indifferently either with the ordinary Brush regulator or with an electric governor on the engine. In series with these 15 arcs are fifty 32 candle-power incandescents of the Bernstein pattern, fitted with an automatic short-circuiting device (Fig. 2) brought out by Mr. Goldston. Two strips of platinum, T T (Fig. 3), are fastened to the leading-in wires W W, and fit loosely on to the china wedge V, which is suspended by the spring S. Fastened to the base of the wedge is another strip of platinum, P P (Fig. 4), the leading wires, W W, running freely through large slots at the extremities of this strip. On the filament breaking the two

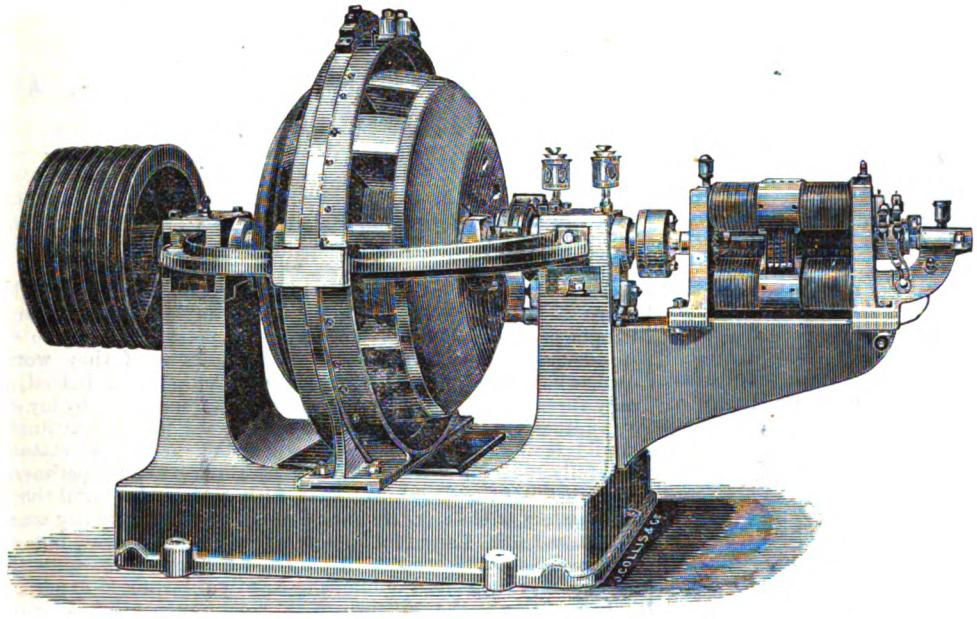

Fig. 1.—Fifty Horse-power Mordey Alternator.

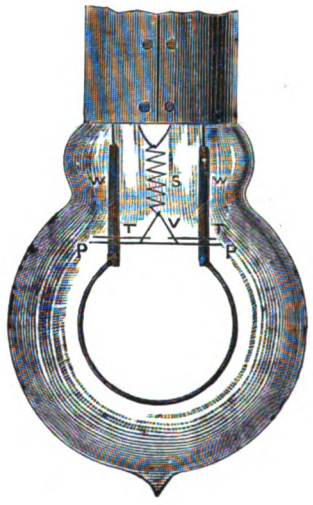

Fig. 2.

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halves fly apart, and the separation of T T allows the spring to lift the wedge, bringing P P into contact with the two upper strips; the break is thus bridged, and the continuity of the lamp circuit is maintained. The Planet Electrical Engineering Company will run eight 2,000 candle-power Alpha arc lamps, placed in the main building. This circuit will be supplied by an Elwell-Parker dynamo, driven off the main shafting. Scott, Ernest and Co., of Newcastle-on-Tyne, light a bay of the main building with six of their new 2,000 candle-power "Tyne" arcs. These lamps, which are of the rack and pinion type, are arranged in parallel, and the current is obtained from a "Tyne" shunt-wound four-pole machine, with disc armature and deeply embracing pole-pieces. This machine, which is driven by a high-speed Robey engine, gives 65 volts at 850 revolutions. The refreshment stalls are lighted by Elwell-Parker, the lamps being run off a battery of accumulators charged from an Elwell-Parker machine, situated on a stand of Messrs. Crossley Brothers, and driven by one of their gas engines. This stand is profusely lighted by some fifty 16 candle-power incandescents, also run off an Elwell-Parker machine driven by an "Otto." The main shafting of the Machinery Hall, from which will be driven the dynamos supplying current to the various power circuits, is driven by a 30 horse-power compound Robey engine and an 80 horse-power compound engine by Messrs. Ruston and Proctor. Steam is supplied to all the enginess from two 300 horse-power Galloway boilers working at 100lb. pressure. The Machinery Hall is large enough to provide ample room for the engines and dynamos which it is proposed to put in it. A broad gallery runs across the middle of the hall about 15ft. above the floor, from which visitors can obtain a good view of the machinery.

Fig. 3.

Fig. 4.

A novelty in electrical fittings is shown by Messrs. Thonet Bros., of Oxford-street, in the shape of a bent-wood electrolier. The General Apparatus Company have a handsome case filled with their well-known artistic fittings, shades, electro-medical apparatus, switches, &c. Mr. Julius Sax shows a large assortment of burglar alarms, electric tell-tales, electric water-gauges, and similar apparatus. The Admiralty send an interesting exhibit, comprising several Whitehead torpedoes, Wheatstone's firing keys, and other submarine mining instruments. Nalder Brothers and Co., of Horseferry-road, Westminster, have a very creditable exhibit of electrical and electrical engineering instruments. Among these we noticed the ammeters and voltmeters brought out by the firm, which combine good strong work with high finish. The former have a very nearly even scale from beginning to end, while in the voltmeters the last half of the reading occupies nearly four-fifths of the whole scale. There is also an arc lighting ammeter with a similar scale, *i.e.*, with the readings near the normal current as much spread out as possible. The latest pattern of Profs. Ayrton and Perry's secohmmeter * is also shown, and the "secohm" standards are expected very shortly. The firm also show their form of D'Arsonval galvanometer and the usual standard patterns of resistance coils, bridges, and reflecting galvanometers, the latter having a convenient arrangement of the coils which makes the needle system very accessible. The whole exhibit is noticeable for the first-rate workmanship and finish for which this firm has acquired a high reputation. Henley's Telegraph Works Company, Walter T. Glover and Co., and John Fowler and Co. show a varied assortment of electric light and telephone cables, the last-named firm making a fine display with Tatham lead-covered cables. Lacombe and Co., of Westminster, who are supplying all the carbons for the lighting of the Exhibition, exhibit battery, telephone and electric light carbons, the latter ranging from the tiny pencil of the laboratory lamp to the huge fluted rods for lighthouse and search-light work. Conradty, of Nuremberg, also shows a large variety of arc light and telephone carbons. The Electrical Power Storage Company have a striking exhibit, comprising the different types of their storage cell, and a regulating switchboard fitted with their steelyard ammeter. Buller, Jobson and Co. exhibit, amongst other things, a large standard of wrought-iron poles and channel arms, which is fitted with over 400 varieties of insulators. A neat and workmanlike display is made by Mr. T. Coad, of Soho-square, who shows a number of portable electric lamps for miners. The Edison-Swan Company have a large case containing incandescent lamps of every candle-power and variety of bulb. Mr. J. C. Lord, of Birmingham, shows a very compact arrangement, consisting of a Waverley turbine and a 5-unit shunt-wound Elwell-Parker dynamo, coupled direct on the same bed-plate. The turbine runs at 1,100 revolutions and is capable of working up to 22 horse-power.

The heavy electrical engineering exhibits, as we have remarked above, are not at present in a very forward state, but they will, when ready, be of an interesting description. Messrs. Laing, Wharton and Down will exhibit the Thomson welding apparatus; the United Electrical Engineering Company will have in operation a telpher line; and the display of motors and electric light engines promises to be varied and excellent. The National Telephone Company, it should be mentioned, are very much to the fore with a most artistically-got-up call office, which has been specially opened for the convenience of visitors to the Exhibition.

* See *Electrician*, June 28, p. 193.

LIGHTNING, LIGHTNING CONDUCTORS, AND LIGHTNING PROTECTORS *

The following is the reply to the discussion on "Lightning, Lightning Conductors, and Lightning Protectors," communicated by Dr. Lodge to the *Journal* of the Institution :—

To a person unaccustomed to controversy, like myself, I find there is an absurd tendency to accept any position which may happen to be suggested as appropriate to me, and to reply to objections raised against a number of shady views as if they were my own, when they are really not mine at all; being, indeed, often only supposed to be mine because they are repudiated by my critic.

Another tendency, more strenuously to be guarded against, is a stupid feeling of semi-irritation when one finds that statements carefully recorded as the result of much thinking and experimenting, combined with some acquaintance with the fundamental theory of the masters of the science, are called dogmatic and lightly set aside, not on account of any real objection or valid argument, but solely and conspicuously because they do not happen to fit in with the speaker's preconceived opinions or hastily interpreted experience.

In replying to the criticisms with which my paper has been thus far honoured, I shall endeavour to resist both these tendencies; and especially shall I try to pick out of the criticisms those points which seem to me wholesome and salutary, and which I can more or less completely accept.

First of all, I must clear away some misapprehensions which have arisen in connection with questions of history and priority. They have arisen partly through misapprehension of what I said or intended to say, partly on account of a distinct oversight on my part in not acknowledging some prior work of Professor Hughes and M. Guillemin in the same direction.

To take the last first. I well knew that experiments in connection with lightning protectors had been made by M. Guillemin and Professor Hughes, because after my Society of Arts lectures Professor Hughes was good enough to write me an account of these experiments, and to consent to my request that his letters should be published in *The Electrician*. There they are for all to see, and it was a mere oversight that I did not refer to them in the corresponding portion of my paper. I suppose it was because I was trying to explain the *facts* quickly, and was not thinking about history or priority. I can assure Professor Hughes that nothing was further from my intention than to claim, or by silence to suggest a claim to, any priority in connection with such experiments.

These experiments showed clearly, in 1865, that no simple shunt arrangement could entirely protect a telegraph instrument from a Leyden jar discharge; and though they hesitated to press their conclusion to the case of lightning in all its completeness, yet I venture to think their experiments demonstrated this also. Demonstrated—not, of course, that lightning protectors can never protect,

* From the *Journal* of the Institution of Electrical Engineers.

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nor that they may not always *partially* protect, but that in a number of cases they may partially, yet very seriously, fail.

That is one point where I hope I have now set myself right; the other is due, not to an oversight of mine, but to a misapprehension by my critics of what I intended to say. In emphasising the importance of the "impulsive rush" case of lightning discharge (the only one very liable to occur, perhaps, during a heavy shower) with reference to the absence of protective virtue from points, and the ease with which they, as well as everything else, could be struck by a noisy and destructive flash, I said: "The steady strain case was the only one ever contemplated by the older electricians; in fact, so far as I know, it was my experiments last year which first called attention to the other case."

These words I used, and these words I still repeat. But the reason I use them was not, I need hardly say, to claim a miserable figment of priority in so trivial a matter, but to emphasise the fact—for I believe it to be a fact—that the impulsive rush case of lightning discharge had not previously been attended to, and that hence many vitally important features had been overlooked.

In the "steady strain" case, points fizz off quietly and are not easily struck by a flash. In the impulsive rush case (*pace* Mr. Wimshurst for the present) they do nothing of the kind.

The important thing, therefore, in the words I have quoted is not the words "my experiments," but the words "experiments last year." It is not to claim the authorship, but to emphasise the recentness of the observations of this hasty and unprepared-for discharge.

It may be that the calling attention to the possibility of this case of lightning discharge is after all not recent—I only said it was recent "*so far as I know;*" but, if noticed before, it has not been emphasised or even mentioned in any books or papers on the subject that I have seen. Nor, indeed, do any of my critics really assert that it is an old idea.

Professor Hughes seems to think that I mean, by "the impulsive rush," a Leyden jar discharge in general, and refers me back to the year 1752, when a Prof. Muschenbroeck, or his pupil Cuneus (*vide* Ganot or Deschanel *passim*), appears to have anticipated me by something over a century. But the gentleman who first noticed an electric spark—Dr. Gilbert, I presume—must be credited with a still earlier knowledge of an "impulsive rush" in that sense. That, however, is hardly the sense I intended.

Mr. Wimshurst, in his remarks at the first evening of the discussion, seemed to think I meant to claim the mode of obtaining impulsive rushes from the outside coatings of two Leyden jars; and pointed out that his machines were so arranged that the outside coats of jars could at any time be conveniently connected to the outer circuit.

Fortunately, I did not mean or imply this either; though, forgetfully, I might accidentally have implied something of the sort, because I cannot help perceiving how much more neatly many Leyden jar experiments, recorded in books or shown at lectures, could be performed, if this mode of connecting to the outside circuit were more generally employed, instead of using a discharger worked by hand or by pulling a string. The advantage of having all the variable part of the circuit at zero potential up to the very instant of discharge, is so marked, and I have used this arrangement so frequently, that I might have been tempted to forget that it was not really a perfectly well-known, though too frequently forgotten, method. I am sure, however, that when attending Prof. Carey Foster's classes, long ago, I saw Leyden jars thus connected up to magnetising spirals or other such things; and I seem to remember also having first seen it with something of the same sort of puzzlement as to the way it acted, which I detect, or fancy I detect, in some few of the speakers, especially during the first evening, with regard to case *b*.

Many remarks have been made—and some weighty ones—on the subject of the probable absence of conducting power in clouds, and the consequent difficulty in satisfying the conditions of the B flash (*i.e.*, the impulsive rush, or spark between bodies initially at the same potential). I admit at once that obtaining B flashes from metal sheets proves nothing whatever concerning the possibility of obtaining them from clouds. But my argument is rather converse to this. I argue (whether rightly or wrongly) that flashes often occur from clouds under circumstances which, under the *a*, or steady strain, or high potential condition, scarcely seem natural. Thus points are sometimes struck and melted by flashes: and it is not easy for them to be struck in case *a*. Moreover, from a cloud violently raining flashes occur; whereas one would expect rain to lower the potential gradually. Again, from a cloud resting on a hilltop flashes occur; and sparks from a badly-insulated body are at once suggestive of impulsive rush conditions—that is, sparks from a body of zero potential. Similarly, I understand that a cloud perforated by the Eiffel Tower has carried on a thunderstorm to people below. I doubt if any of these things could easily happen under the conditions of case *a*.

But it will be said surely some of the facts you adduce establish the bad conducting power of clouds. To a great extent the Eiffel Tower case (if a fact) does. The hilltop case merely proves that the *hill* was a poor conductor. I can easily get long sparks from metals roughly uninsulated, as by wood, water, or soil.

Suppose, however, it admitted (not as proved, but as probable) that clouds are poor conductors, what then? All that we can assert is that the whole of a cloud or even a large portion of a cloud, is unlikely to discharge at once. I quite think that that is so. A calculation of energy shows that a violent flash need only discharge a very small portion—a few square metres—of a charged cloud, and that the same cloud may therefore go on sparking for a long while, as, indeed, it appears to do. Now no great conducting power is needed for a discharge from a small area at a great elevation: the lateral component of rush is in that case negligible.

Of course it *may* be asserted that clouds conduct so badly that no "flash" in the proper sense can ever occur. An answer to that assertion is the existence of lightning.

All that poor conductivity in clouds has to say concerning the impulsive rush seems to me this: that when any part of the cloud receives a violent disturbance from some A flash in its neighbourhood, that same part which receives it is most likely to spit off the consequent B flash. Whereas, with a perfect conductor, any other portion would be almost equally liable. Poor conductivity goes, indeed, to *help* the violence of the impulsive rush; for the essence of it is that a conductor of small capacity at zero potential shall be suddenly overloaded. Now if a charge suddenly communicated to a portion of a large cloud could instantaneously be shared with the whole, the potential would be reduced, and nothing very violent need occur.

This may sound like special pleading, but it is only recording the circumstances that have to be attended to. What the *facts* are must be determined by direct observation on flashes and clouds.

But let me here beseech meteorologists to remember that establishing the condition for some one flash or class of flashes does not establish the impossibility or improbability of very different conditions obtaining elsewhere or at other times. There are varieties of thunderstorms, varieties of clouds, and varieties of flashes. Every good and accurate observation will be a help to fuller knowledge, but it will take years of enlightened experience and observation before all possible varieties and circumstances of discharge can be supposed exhausted.

Before leaving this subject I should like to remind the Institution that I have never hesitated to contemplate the imperfect conductivity of clouds, whatever the consequences of that imperfect conductivity might be; and in proof of this I enclose an extract from the report of my remarks at Bath, as published in the scientific journals at the time:—

Extract from British Association Discussion.—"There was one point where Mr. Preece might have attacked him, but where he did not think Mr. Preece had made out the full strength of his case, namely, the question—What are the conditions of a flash? He (Prof. Lodge) had assumed that a flash behaves, or may behave, like the discharge of condensers in a laboratory; but it was a question whether a cloud discharge was of this kind. A cloud is not a good conductor; it consists of globules of water separated from one another by inter-spaces of air; it may be compared, therefore, to a kind of spangled jar; when a spangled jar discharges there is no guarantee that the whole of it discharges, it may discharge out in a slowish manner; it may be that you have first a bit of discharge, then another bit, and so on, so that you may have a kind of dribbling of the charge out of it, and you may thus fail to get these oscillatory and sudden rushes. At the same time he did not think that they could always guarantee doing this with cloud discharges; and it would not be safe in arranging protectors to protect for only one case, and that the easiest; they must provide for the possibility of a sudden and violent discharge. Still, the conditions of actual lightning were to be ascertained by observing lightning, and not by experiments in the laboratory."

Proceeding now to the remarks of the first speaker at the second evening of discussion, I must draw a clear distinction between Mr. Wimshurst's experiments and Mr. Wimshurst's comments thereupon.

With respect to the experiments, I feel obliged to him for exhibiting and emphasing several points which, for want of time, or otherwise, I had rather slurred over; also for recalling to my memory a little point which I had forgotten, though it is in my assistant's note book; and, lastly, for detecting an interesting matter which had escaped me.

To take these successively. 1. He seems to have exhibited side flashes, from badly earthed conductors and to well earthed bodies, more satisfactorily than in my hurry during the Paper I managed to do. It is not likely that he exhibited them so strongly as I have obtained them in the laboratory, because the violence of many of these side flashes is a thing that strikes observers with astonishment; and with a *long* conductor, as stout as you please, it makes very little difference whether its far end is "to earth" or not. It does undoubtedly make some. Prof. Threlfall, and Mr. J. Brown,

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of Belfast, have both seen these effects at Liverpool, and neither, I fancy, would contemplate with equanimity the idea of bringing their knuckles near a conductor when struck, however well earthed it was.

At the same time it is perfectly true, and I must have often recorded the fact, that from a well-earthed conductor the sparks will not charge a Leyden jar. They jump in and out again. Sometimes, indeed, there is a residue of charge, but it is accidental what sign it is, and it is always merely the tail end of a series of oscillations cut off by resistance at some arbitrary point.

A more striking experiment is to connect a gold-leaf electroscope to the conductor. If the connection is metallically perfect the gold leaves are nearly quiescent. With imperfect connection they may diverge; they always slightly kick. The experiment is a little rough on the electroscope, for it strains the leaves downwards, and blows fragments off sometimes; but it is a striking thing to be able to take a ½in. or even a 1in. spark, of considerable power and noise, from the cap of an electroscope whose leaves hang stiffly down all the time and barely twinkle.

These side flashes are not very painful; they look worse than they feel; the charge hops in and out of you without going through you much or disturbing the nerves seriously. I by no means assert that a man would *necessarily* be killed if touching a conductor struck by lightning; but it would surely be a position of considerable danger.

2. The fact which Mr. Wimshurst has observed, but which I had missed, is this: that when side flashes are tried for at different points in the length of a wire joining the outer coats of two equally-insulated symmetrical jars, they are obtained more strongly towards either end of the wire, and are not obtainable at all at the middle. The middle is, in fact, a node. There are stationary waves set up in the wires, whose ends are now at high potential and now at low potential alternately, just like a long bath which has been tipped and set down sharply. To and fro the water splashes, and the ends are now at high and now at low level alternately, but the middle is a node and remains of average level all the time; it is at zero potential, and no spark is obtainable from it. It is quite an interesting fact, and one that it would have been a pity to miss. I am sure we are obliged to Mr. Wimshurst for discovering it.

3. Lastly. The little point Mr. Wimshurst has recalled to my memory is this: that when a cloud or top-plate is negative, a small terminal or point gets struck rather more easily—*i.e.*, at a lower elevation—than a big terminal or dome, even under the circumstance of the impulsive rush.

The fact is often so; but Mr. Wimshurst's account of it may lead persons who have not tried the experiment to over-estimate the magnitude of the difference, which is frequently quite inappreciable; being, indeed, often non-existent.

If the impulsive rush is violent—*i.e.*, if it proceeds from a pair of large jars, highly charged, into a plate of moderate size—the difference is non-existent. Careful measurement fails to show that the things equally struck are not all the same height; and this whether the "cloud" be negative or positive. This was the case I exhibited at the meeting, and there was no need to notice of what sign the top-plate was. But if the rush be made less violent, either by using small jars or by charging them feebly, a difference is observable. A point then gets struck, as Mr. Wimshurst showed, at a distinctly lower elevation than a knob does, whenever the overhead flash is negative—not when it is positive.*

Those are the facts, and we are indebted to Mr. Wimshurst for calling attention to them, but, as to what the moral and practical bearing of them is, opinions may differ.

Certainly it in no wise upholds the statement that points always discharge silently and cannot get struck, which is what has always been meant by their "protective virtue." Rather it would seem that they get struck in an impulsive rush always as easily as anything else, and sometimes, as Mr. Wimshurst shows, still more easily. For remember that the "striking" is not a fizz or leak of a gentle and protective kind, but is a violent and destructive flash.

The other experiments exhibited by Mr. Wimshurst are less important. One has to do with the experiment of the alternative path, or, as Mr. Wimshurst prefers to call it, a "bye-pass."

I did not make any reference to this class of experiments in the Paper, because I consider I have got to the bottom of them and thoroughly understand their conditions, which I have published; so that, except in a very serious memoir, they are not really discussable.

This may sound a desperately arrogant thing to say, but if so, I cannot help it. One would make no progress at all if one could never get to the bottom of a thing and feel one's ground secure. And I am so profoundly conscious of ignorance with respect to a vast number of phenomena that I have no care to waste time by pretending ignorance where it does not exist.

May I therefore save time by saying that all the experiments of Mr. Wimshurst on this particular matter are completely in accord with my theory;† and also that the remark of Prof. Hughes concerning the probable delay of the B spark behind the A spark is completely borne out by theory. The lag is, in fact, a quarter period of the oscillation.

Referring to another remark, I may also say that at Liverpool we have recently obtained excellent photographs of a slowly oscillating spark on a rotating sensitive disc, and that the constituent oscillations are not only conspicuous, but well spread out and accurately measurable, and in agreement with theory within one half per cent.

Finally, Mr. Wimshurst seems to have exhibited an ordinary spangled jar, in which a charge electrostatically induced in its outer coat exhibits sparks between the spangles in a simple and well-known way. He thinks this is analogous to the sparkings on the wall-gilding excited when an oscillating current is sent through a wire circuit lying on the floor; but, without laying unnecessary stress on the distinction between electrostatic and electro-magnetic induction, I think I am justified in saying that the two experiments are not analogous.

Some remarks which he made in apparent detraction of the Voss machine I do not completely follow. I am very ready to admit that a Wimshurst machine is an excellent instrument, but it is not necessary to condemn the Voss machine, or to suggest that it is worse than an old frictional machine, in order to believe that. The Voss machine I have found most excellent too, and for small size machines I personally perfer it; but that is perhaps an idiosyncracy based upon finding it easier to turn, easier to take to pieces, thoroughly under control, and mechanically simpler. There is not the slightest difficulty in telling which terminal is positive, the brush appearance to the points tells us that whenever we choose to look. Certainly it easily reverses. That is its one objection; and occasionally it is an annoying peculiarity, though I have got pretty used to it.

I should like to remark here, what after all is fairly obvious, how great service has been done by the developers of the modern influence machine, from Nicholson, Varley, and Thomson, to Holtz, who did so much, and on to Mr. Wimshurst himself.

Many of the remarks of Professor Hughes I have already incidently answered or referred to. He says, quite rightly, that I maintain flat ribbon and plenty of surface is an improvement on round rod, but as to whether it is a matter on which very great stress need be laid, I will defer discussion till I come to the observations of the President.

Prof. Hughes' experiments on iron *versus* copper no doubt agree with mine whenever he uses alternating currents of the same frequency, and disagrees when he uses alternating currents of much lower frequency. For telephonic frequencies iron has much greater impedance than copper. Oliver Heaviside does not for an instant deny this, but he says that there may be circumstances in which this extra inertia is an *advantage*, in that it helps to preserve the character, or quality, or shape, of electric waves, although it admittedly transmits more slowly and weakens them. If Mr. Preece and observers in America find in practice that copper wire is better for telephony, as they apparently do, then that means that the character of the vibrations is *sufficiently* preserved in copper, and the comparative absence of retardation is all to the good. It may, however, still happen that in submarine cables iron will show an advantage. It is a curious paradox, no doubt, at first sight, and whether the advantages outweigh the disadvantages in any particular case is a quantitative question of no extreme simplicity though, nevertheless, it has in general terms been worked out.

But the question for ordinary Leyden jar frequencies is much simpler. For them the *impedance* of iron and copper of the same diameter is practically the same, unless the wire is very long or very thin. The *resistance* of the iron is much greater than that of the copper. All this can be expressed, and has been expressed quantitatively, with, in my opinion, complete certainty, and beyond the reach of any but revolutionary doubt to which all scientific doctrines are liable.

And on the practical side one may say this: The circumstance of a telephone wire and of a lightning rod are not only different, they are, in some respects, opposite. The object of a telephone wire is to convey electric waves, unaltered and unweakened, to a distance. One object of a lightning conductor is to wipe them out and dissipate their energy as soon as possible. The very properties which are detrimental in one case may be desirable in the other. It is no doubt a quantitative question how far it is wise to wipe out energy in the lightning conductor itself, and Major Cardew thinks it is unwise to do so at all. Possibly; but at present I hold that so long as total impedance is not appreciably increased, and so long as the margin of melting is not too closely approached, so long it is desirable to dissipate energy wherever you can and to check the violence of the oscillations as rapidly as possible; and hence I hold that a moderate amount of true *resistance* is no defect in a lightning conductor.

Everyone must admire the beautiful method by which Prof. Hughes tests his wires for circular or cylindrical magnetisation.

(To be continued.)

* For measurements *see* Appendix IV. † *See* Appendix I.

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M. LEBLANC'S ALTERNATE-CURRENT MOTOR.*

Alternating currents present some peculiar advantages in the transmission of energy, for they are more easily handled under high tension, and they do not affect the insulation in the same way as do continuous currents. The phenomena of self-induction have hitherto hindered us from realising a motor capable of self-starting and of running at any required speed, whilst at the same time possessing a high efficiency and a considerable output per unit weight. It is thought that these advantages may be realised in the following manner:—

My motor consists of—(1) a fixed armature in the form of a ring; (2) a movable field magnet in the form of a Gramme or Pacinotti ring placed in the interior of the armature and furnished with a collector; (3) a small alternate-current dynamo [or motor] with permanent magnets, whose armature is mounted upon the axis of the machine. This armature is connected in series in the circuit of the first armature, and receiving the current from the line turns synchronously with the generator. Its purpose is to rotate a certain number of pairs of brushes, which rest upon the commutator of the moving field magnet. The number of these brushes is equal to the desired number of field-magnet poles and proportional to the number of alternations of the current which feeds the machine. They are all connected amongst themselves by a short circuit.

Theory and experiment demonstrate that in these conditions—(1) a current always in the same sense is developed in the moving ring [the field magnet], and completes its circuit by traversing the brushes after having excited the field †; (2) a motor couple (torque) always in the same sense (a function only of the intensity of the alternating current traversing the armature and of the speed of the brushes relatively to that of the collector) is determined upon the axis of the ring. The machine is self-starting, and the rotation is in the same sense as that of the brushes. The torque developed upon its axis diminishes proportionately as the velocity increases. As to the work furnished, it is a maximum when the speed of the armatures is equal to one-half that of the brushes.

The armature which has been employed in these experiments was taken from a Rechniewski machine. We have made the brush-holders movable, and the method of gearing obliges them to ma e one-half a revolution during one alternation of the current.

Theory shows that the electrical efficiency of this machine may be made as high as we please, and that the ratio of the E.M.F. which is necessary to send the alternating current through the armature to that which would be required if the self-induction coefficient were zero is very nearly unity. This is due to the fact that the current is not reversed at the same moment in each of the field-magnet coils, but successively in the coils of the Gramme or Pacinotti ring, and, moreover, the reversal takes place at that moment when each coil is solely traversed by that number of lines of force due to its own self-induction. Everything happens, therefore, as if the coefficient of self-induction of machine was reduced to that of the armature alone, and the counter E.M.F. due to the reversals of the alternating current is very small compared with that which is absorbed in the production of work. We expect in this way to obtain an alternating motor which, whilst permitting us to take advantage of the properties of such currents, shall also have as high an efficiency and as large an output as an ordinary continuous-current machine. The type of machine to which we have been led, and which can receive an infinite number of different forms, necessitates no larger number of parts than do ordinary alternating dynamos furnished with separate exciters such as are already in daily use.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *July* 25, 1889.

During the past week the daily papers have been devoting column after column to the weary investigation now going on before a referee with the object of determining whether the infliction of death by means of electricity is a "cruel and unusual" method of execution. The questions propounded to the different witnesses by the examining counsel for the condemned criminal Kemmler have been very much the same as those asked for the past few weeks, the monotony being varied only by the divergence of opinion which seems to exist on those questions. Probably the most interesting information gleaned last week was obtained from Commodore Gerry, one of the Commissioners on whose report the law was adopted. In the course of Commodore Gerry's examination it transpired that the committee had considered 41 methods of inflicting death, but at last weeded these down to four, namely, the guillotine, the garrote, poison and electricity. The first was rejected because of its traditions and its ghastly connection with the French Revolution; the garrote, which was very effective and had much to recommend it, was used by only one civilised country, Spain, and was, moreover, a relic of barbarism, and disfigured the criminal. Prussic acid was considered, but death from it was not deemed certain, as it became decomposed, and, moreover, the smell was dangerous to those who handled it. It also required to be administered by a man of considerable medical knowledge, and no one of sufficient ability, it was claimed, would consent to become public executioner. Morphine was also suggested, but the difficulty was to find what dose would prove fatal in each case, and the medical profession protested against the prejudice it might cause in the public mind. The fourth method, electricity, was finally decided on, and the Commission issued circulars and sent them to the various judges and doctors throughout the State, asking them which of the four methods named they thought better than hanging. 275 answers were received. Of these 81 thought hanging good enough, 75 advocated electricity, and the rest were scattered. Considering this admission of the manner in which the final determination was arrived at, it seems rather cool that the opinion of electricians should not have been consulted on the proposed method in the same way as the proposed execution by means of narcotics and poison was submitted for approval to the medical men. It would be only fair to suppose that if this had been done the verdict would have been almost unanimous against electricity amongst those who come in daily contact with it. Amongst the various witnesses who were called last week was Mr. Francis W. Jones, electrician of the Postal Telegraph Company, who testified as to the varying resistance of the human body, measured under different conditions. Dr. Landon C. Gray, professor of nervous diseases, was also of opinion that electricity was an uncertain means of killing. The testimony of a man who had been struck by lightning was also taken, to show that a current of electricity, even in the shape of lightning, does not inevitably produce death. Among the witnesses also called this week was Mr. T. A. Edison and Mr. A. E. Kennelly. Mr. Edison was decidely of the opinion that 1,000 volts of alternating current could be depended on to do the work surely and effectively, but when asked the stereotyped question, "What do you base this opinion on?" he admitted that it was merely an opinion and not based on the results of observation, as, indeed, was self-evident.

Now that Canada has its trans-continental railroad and telegraph system, it is looking about for further extension of its facilities for communication, especially with the outer world, and the latest project advanced is the laying of a Canadian trans-Atlantic cable. Various arguments are brought forward to show that such a cable has a *raison d'être*, but it is probable that the existing cable companies will hardly see it in the same light. It is proposed to lay the cable on an entirely different route from those existing at present, most of which are laid around the banks of Newfoundland, the furthest north being the Anglo-American cables which run from Heart's Content to Valentia. It is proposed to lay the new cable still further north—from Greenly Island through the Straits of Belle Isle, straight across to the nearest point in Ireland, taking a course nearly due east and west. This route is claimed to be 150 miles north of any Atlantic cable now laid, and the depth of ocean is also said to be considerably less, so that any interference with other cables is out of the question, and repairs could be very easily made. The company would only have to provide and maintain a main cable of 1,900 miles in length, the connection at the eastern terminus being with the Government, Post Office, and telegraph service, and at the western end with the Canadian Government telegraph service at Greenly Island

* Paper read by M. Leblanc before the French Academy, July 29th, 1889 (*Comptes Rendus*, Vol. CIX., No. 5).

† [As this current is induced by the alternating current in the fixed ring armature, the description would be clearer to the English reader if the terms "field magnet" and "armature" as used in the text were reversed.—ED. *E.*]

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and with the Straits of Belle Isle. The cost of this cable is estimated at about $1,600,000, and it is said that one of the principal cable manufacturing concerns in London has tendered to lay the same for the sum of $1,500,000. With this low cost of cable and the other advantages above-mentioned, it is claimed that sufficient reasons exist for carrying out the proposed enterprise, but with ten cables now landing in Canada the actual necessity for another seems somewhat problematic.

The gravity battery has been so long and so well known, and so many modifications have already been made upon it in order to overcome certain defects which are inherent in the battery, that it would seem difficult to conceive of anything new in this field; but it appears that a very simple and decided improvement has been made by Mr. P. B. Delany, whose synchronous multiplex telegraph system is already known to your readers. Briefly stated, Mr. Delany overcomes a number of inconveniences attending the use of the gravity battery by covering the zinc with a porous material, and likewise inserting the sulphate of copper in an envelope. Thus he encloses the zinc in a paper envelope, and the sulphate of copper crystals in straw-board box. When the zinc is so enclosed the covering protects it from the hydrogen gas which constantly arises from the electrode, carrying with it sulphate of copper. The covering also prevents stalactite formations of copper on the zinc, which occur in the ordinary gravity battery, and goes down into the solution of sulphate of copper, solidifying it so as to frequently render the removal of the copper electrode difficult without breaking the jar. The covering also retards the dissolving of the sulphate of copper and an unnecessarily free action upon the zinc, and wasteful supersaturation. Mr. Delany has found by actual test that after three or four days, when the two elements, sulphate of copper and sulphate of zinc, have been produced to a proper working extent, the resistance of the battery is no higher, and the current is even greater than with batteries of the ordinary form. Another little improvement introduced by Mr. Delany relates to the prevention of creeping salts in batteries. In order to avoid this the inner lip of the jar is coated with asphalt varnish, to which ordinary white sand is applied, thus leaving a rough surface. This surface, it would seem, breaks up the crystals, and, indeed, prevents them rising above the lower edge of the roughened surface. Of 100 cells in Mr. Delany's office thus treated six months ago, not one shows the slightest trace of salt creeping, as I have had occasion to witness myself.

Mr. Rankin Kennedy's work in the department of alternating currents, which is no doubt well known to your readers, will shortly, it would seem, play quite a prominent part in the litigation which is about to be commenced on this side of the water by the Westinghouse Company in support of their claims to control the alternating system of distribution. The suits which it is said are about to be brought are based on a patent granted last week to Mr. Rankin Kennedy and assigned to the Westinghouse Company, which it is claimed covers the multiple arc method of distribution by means of transformers. The patent contains but a single claim, which, in view of the importance attached to it, it may be interesting to your readers to see in full, and I therefore give it herewith.

"The method of distributing and regulating alternating electric current by secondary generators, which consists in producing in two or more derived circuits constituting the primaries of two or more secondary generators a counter E.M.F., which, when any secondary is opened, is practically equal to the applied E.M.F. in the primary, and in controlling said E.M.F. by the current flowing in the corresponding secondary, when the secondary is closed, in such manner that the current in the primary shall vary with, and be approximately inversely proportional to, the resistance in the secondary, substantially as described."

As I mentioned some time ago in this letter, a patent has been recently issued to Mr. Weston on the construction of armature cores by means of laminated plates insulated from each other. Grave doubts have, however, been expressed by parties using this form of armature as to the validity of this patent, in the face of previous work done in this direction. In alluding to this, a correspondent in one of the New York electrical journals cites a passage appearing in an English journal, published in 1873, as a translation from the *Comptes Rendus* of the Académie des Sciences, Vol. LXXVII., No. 9, in which M. A. Pellerin, in a note on the Siemens' bobbin, refers to the heat developed in the same when made solid, but shows how this had been avoided by constructing the armature of discs of soft iron insulated from one another. This would seem to be clear in its application, but considering the glorious uncertainty which has heretofore characterised electrical litigation, no one can hazard an opinion on the outcome of a legal test.

Nearly all vessels which have lately passed over the course usually taken by the Transatlantic steamships have reported the sighting of icebergs, and the collision of the "Saale" with one of these has again revived the question of the avoidance of danger from this source. Among the various methods proposed for detecting the presence of icebergs in time to avoid danger those involving the application of electricity seem to be in the large majority. Most of these methods are based on the lowering of the temperature of the water due to the presence of the iceberg, which decrease in temperature would be indicated by some thermostatic arrangement in connection with an electrical indicator of some kind. This idea, though very pretty in theory, cannot, however, be relied upon in practice, as pointed out by Mr. F. R. Colvin, in an article published in the *Electrical World*. As Mr. Colvin puts it, the indications of such an instrument would depend entirely on the direction of the currents surrounding the iceberg, both at the surface and below, and also, evidently, on the direction in which a ship approached the berg. Thus, if the cold current were flowing towards the ship the indications would probably be given in time to avoid a dangerous collision, which, again, would also depend upon the tactical diameter of the ship. But, on the other hand, if the ship approached the iceberg in the same direction in which the cold current was flowing from it, the instrument being relied upon for timely warning would, of course, fail to operate, and would thus be more a source of danger than a safety device. The field, therefore, is still open for the ambitious inventor.

Electrical welding has been making satisfactory advances in this country, and quite a number of wire and cable makers have adopted the process, among them the Trenton Iron Company of Trenton, N.J., and the well-known firm of Roebling and Sons. A recent important advance in this method of welding is reported, and consists in the actual welding, end to end, of the two sections of a cable containing no less than 55 strands. The cable, which consists of hard-drawn low carbon steel, was so manipulated that each strand was directly welded to the one opposite to it in the two sections, so that the finished joint occupied no greater area than that of the original section. The tensile tests of the welded cable give the most perfect results, the maximum tensile strength of the welded specimens averaging from 80 per cent. of the maximum load of the original section. Severe bending and twisting tests give an equally good result, the cable resisting bending back and forth many times through an angle of 180deg. at the weld. The important advance achieved in this direction will be appreciated by engineers, and cannot fail to extend the use of the cable in construction work considerably.

No event of importance occurs now-a-days but the electrician is called into service, and the late great Sullivan-Kilrain prize-fight was no exception to the rule. As the precise location of the battle-ground was kept a profound secret in order to avoid police interference, the regular telegraph service could evidently not be depended upon to furnish the news with sufficient promptitude. The New York *World*, however, with its usual enterprise, in order to obtain the first news regarding the battle, had arranged to run a telegraph line from the battle-ground to the nearest wires. For that purpose they had rigged up several miles of wires on reels, with posts that could be quickly erected, instruments, &c.—in fact a small field telegraph system, which was actually in satisfactory operation shortly before the fight began. But their labours unfortunately went for nought, for, just as the fight was about to begin, the main-line wires were cut, thus, of course, cutting off all communication. As a stroke of enterprise, however, the fact is worth mentioning.

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CORRESPONDENCE.

THE INDUCTANCE OF UNCLOSED CONDUCTIVE CIRCUITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In my communication to this journal on "The Mutual Action of Rational Current Elements," *The Electrician*, December 28, 1888, p. 229, I described the meaning of, and gave the formula for, the mutual energy M of a pair of rational current elements.

Thus, let C_1 and C_2 be their moments, r their distance apart, ϵ the angle between their directions s_1 and s_2, μ the magnetic inductivity of the medium (uniform), and M the mutual energy. Then,

$$M = \mu C_1 C_2 \left(\frac{\cos \epsilon}{r} + \tfrac{1}{2} \frac{d^2 r}{ds_1 ds_2} \right) \quad . \quad . \quad . \quad (1)$$

It follows immediately from this that the mutual inductance of any two linear circuits is

$$M = \mu \int\int \left(\frac{\cos \epsilon}{r} + \tfrac{1}{2} \frac{d^2 r}{ds_1 ds_2} \right) ds_1 ds_2 \quad . \quad . \quad . \quad (2)$$

M being now the mutual inductance. If the circuits are closed the second part contributes nothing, and we have

$$M_0 = \mu \int\int \frac{\cos \epsilon}{r} ds_1 ds_2 \quad . \quad . \quad . \quad (3)$$

the common form of Neumann's equation, with the μ prefixed to adapt it to Maxwell's theory.

But if the lines are unclosed, then, according to my description of the nature of a rational current element, the linear currents become closed by means of currents uniformly diverging from their positive ends, and uniformly converging to their negative ends. The second part of (2) is now finite. Let P_1 and P_2 be the positive poles, N_1 and N_2 the negative poles of the linear currents, and let the value of the second part of (2) be M_1. It is given by

$$M_1 = \frac{\mu}{2} (P_1P_2 + N_1N_2 - P_1N_2 - N_1P_2) \quad . \quad . \quad (4)$$

where P_1N_2 means the length of the straight line joining P_1 to N_2, and similarly for the rest. We may, therefore, calculate M by Neumann's formula, applied to the linear circuits, and then add the correction (4) to obtain the complete expression.

A practical application is to the theory of a Hertzian oscillator, at least of a certain kind. Let a straight wire join two conducting spheres, or discs, &c. Imagine an impressed force to act in the wire, and to vary in any not too rapid manner. The current will leak out (or in) from (or to) the wire as well as the terminal conductors, but if they are relatively large nearly all the current will go across the air from one terminal conductor to the other, and we may ignore the wire leakage. The permittance S is then that of the dielectric between the two spheres (say), and is quite definite. Also, if the changes of current are not too rapid, as mentioned, the current in the air will follow the lines or tubes of displacement. The inductance L is therefore also quite definite, in accordance with Maxwellian principles, so that the natural frequency of oscillation of the condenser-conductor circuit can be calculated with considerable precision from the dimensions.

If, as an illustrative approximation, we suppose the current to come from the centre of one sphere and go to that of the other, and then diverge or converge uniformly, we have to find the inductance L of a straight wire or tube of length l and radius a, with terminal continuations as before specified. In a Paper in the July *Phil. Mag.* Prof. Lodge calculates L without any allowance for the current in the dielectric, viz., by Neumann's formula (3). We have therefore only to examine what the correction (4) amounts to.

In the case of two very close parallel lines, we may put

$$P_1P_2 = 0 = N_1N_2, \text{ and } P_1N_2 = P_2N_1 = l$$

so that the correction is simply $-l\mu$. That is, if the dielectric current is ignored, (3) overestimates M by the amount μl. The same applies when it is the inductance of a straight tube or solid wire that is in question. Deduct its length in centimetres from the uncorrected to obtain the true value, in C.-G.-S. electromagnetic units, *i.e.*, centimetres.

Prof. Lodge (*loc. cit*) also gives the formula which Hertz says Maxwell's theory gives. On making the comparison, I find it is equivalent to adding, instead of deducting l, from the result of Neumann's formula.

Perhaps Mr. Preece, who has distinguished himself by his experimental measurements and calculations relating to the coefficient of self-induction of straight wires, would give his opinion upon this point.

It should be remarked, as an essential condition of the validity of the process described above, when practically applied, that the changes of current must not be too rapid. When the changes are slow the immense speed of propagation of disturbances through the air causes the electric displacement at any moment in the neighbourhood of the vibrator to be very nearly that which would obtain according to electrostatic principles, and the current to follow the tubes of displacement. But go to the other extreme, and imagine the changes to be so rapid that waves, whose length is a fractional part of the length of the vibrator, are produced. It is then clear that the theory would not apply at all, neither as regards the inductance nor the permittance. Now Hertz, in that series of brilliant experiments which have gone far towards practically establishing the truth of Maxwell's inimitable theory of the ether considered as a dielectric, employs sometimes waves which are not very much longer than the vibrator itself. Only close to the vibrator, therefore, do we have the electrostatic field (approximately) predominant, and we may expect a sensible error in applying the electrostatic theory. It is, however, quite easy—in fact, easier—to use longer waves. But in any case, the *exact* calculation of the permittance and inductance of a vibrator involves a good deal of mathematics to find relatively small corrections.—

Yours, &c., OLIVER HEAVISIDE.

July 21, 1889.

ALTERNATING MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having read with great interest your able leader on Alternate-Current Working, may I go so far as to disagree with some of the remarks you make, giving my reasons? So far from the old theory of alternating motors being non-existent or vague, it is perfectly clear—namely, that an alternating motor with back electromotive force equal to or greater than the dynamo, can only work as a motor by virtue of its self-induction. Mr. Mordey denies this, but does not say how it does work. The analogy with a direct-current motor in misleading. A direct-current motor has less electromotive force than the generator, and controls itself by variation of speed. The demagnetisation of the field of an alternator by the current is perfectly well known to dynamo makers. The effect of the armature current may be divided into cross induction and back induction, to use my own terms. The cross induction is taken into account by Prof. Thompson when he makes his coils to suit, and the back induction is taken into account by every maker who puts on extra field excitation to neutralise it. I think the questions have also been discussed by Dr. Hopkinson in Royal Society Papers. As far as the field is considered, cross induction, and more especially back induction, are permanent effects. You say the experiment of the 2,000 and 1,000-volt machine is not a proof of the great self-induction of the machines, because it can be explained as weakening and strengthening the fields, but that is simply self-induction under another aspect. When I spoke at the meeting I did not think of it as weakening and strengthening the fields; but I objected, as I always have done, to the loose way in which the term self-induction is commonly used. A Paper man appears to think of electrical inertia, or self-induction with a constant coefficient; and a great many dynamo men—I among others—prefer to consider the whole electromotive force generated one way or the other.

Mr. Mordey's experiment with the 2,000 and 1,000-volt machines seems to have confused people hopelessly. It is not

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a parallel-motor case at all, and most of the conclusions drawn from it must be reversed to have any meaning.

I would like to put an elementary case: Assume no self-induction in the armature circuits. Take two similar machines of equal E.M.F. Imagine them cophasedly synchronised. No current passes, and no work is done on or by either. Lessen the field excitation of one. It is at once a motor at every part of the period, except at the points of zero current. If no load is on it will lead, and its lead will increase till it is a quarter of a period ahead of the dynamo. The two machines are practically short-circuited then. The motor gets equal impulses backwards and forwards. If load is put on it reduces its lead so that the backward impulses are less, and forward greater, till it is cophasedly synchronised. Such a motor is really only capable of use on a series circuit, and such a series motor gives a good full load when the current is forced through it when cophasedly synchronised—that is, on a constant-current circuit. At no load the armature loss is as great as at full load. I explained this in 1887. A motor with small E.M.F. cannot, therefore, be used on parallel mains, for at no load it tries to short-circuit them. If its E.M.F. is just under the main E.M.F. enough to let the full load current go through at full load, the current obviously increases enormously at no load. When working off a single dynamo of course this effect is masked.

The action of two similar machines of equal and opposite E.M.F. is much more difficult to put clearly. Suppose them cophasedly synchronised. Then make one lag. At some instants each is acting as a dynamo, and at some as a motor. The current at any instant is equal to the sum of the E.M.F.s divided by the resistance, when they are in the same direction, and to the difference when they are opposed, as they are most of the time. Any instant when one is a motor has a corresponding instant when the other is a motor, so there is no control. The system is perfectly symmetrical, and both do equal work on their armature resistances. We are assuming the fields constant. Leave the field excitation constant, banish coefficients of induction and curves of sines from the ideas, but assume that the armature currents may weaken or strengthen the fields as the case may be. Think of the leader first. As a conductor comes into the field it generates E.M.F. and produces a current. If it worked on resistance the current would be at a maximum when the conductor was half-way past the pole, and would fall correspondingly afterwards; the lagging machine interferes, however, and by its lagging but opposed E.M.F. it stops and reverses the current before the conductor is much past the middle of the pole. In fact, the current due to the machine comes sooner than if it were produced by the leading machine, and later if produced by the lagger. A current lagging after the E.M.F. weakens the field, and a current preceding the E.M.F. strengthens it. The leading machine, therefore, has its field strengthened, while the lagger's is weakened; the lagger thus becomes a motor. It seems a common error to suppose that in driving a motor the dynamo current lags because there is self-induction; it really leads.

Exactly the same result could be got by treating the machines as having unaffected field magnets and constant coefficients of self-induction and curves of sines.

In parallel running the lagging dynamo need not suddenly turn into a motor, all that is needed is for its load to be reduced.

A perfect motor could be got without the armature weakening of the field, or cross or self-induction, if the field could be weakened artificially, as in the hypothetical case taken before. A 100-volt motor would just have its field weakened till it took its full load current without lagging, and would then give the same output as when used as a dynamo or resistance. When the E.M.F. is equal and lagging is necessary, the current should be as nearly in opposition to the opposing E.M.F. as possible. As far as I understand what you and Mr. Mordey mean by a "stiff" field, just the opposite is required, and the 2,000 and 1,000-volt experiment show that is just what Mr. Mordey has really got.

I do not quite know what is meant by the "vital point being the relation of the stability of synchronisation upon the armature inductance." It sounds very much like the old theory, that you want to keep your machines together with the least waste of power over armature resistance. But it is an impressive way of saying something. The main drawback to an alternating motor is that its armature current is at the wrong time, so that the armature loss is heavy in proportion to its output. Mr. Mordey never gave his armature currents.

I must say I do not think we will get much further if self-induction and armature reactions are sometimes mixed up and sometimes separated, and I really doubt whether an army of third-year students, glittering with secohmmeters telling us how many of Profs. Ayrton and Perry's things there are in each stationary armature, will get information fit for anything better than a Paper.

I do not wish to attack Mr. Mordey more than necessary for giving my own views clearly. I do not really understand his alleged ideas fully enough to go into them. One of us must have talked a great deal of nonsense.—Yours, &c.,

JAS. SWINBURNE.

[This letter having arrived only just in time for the present issue, we must defer any reply until next week. Meanwhile we shall be glad to hear from other readers upon the subject.—ED. *E.*]

THE USE OF CARBONATE OF SODA IN SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest the published report of Mr. Wm. H. Preece's Paper on "Secondary Batteries," read before the Society of Arts on May 1st, 1889.

The use of carbonate of soda in the electrolyte in order to prevent sulphating, according to my experiments, is attended by serious difficulties not mentioned by Mr. Preece.

If the battery is in constant use a grey precipitate rapidly forms, which falls to the bottom of the jar. It is apparently a sodic-sulphate of lead, and a non-conductor, but particles of active material become incorporated with it, and soon short-circuit the battery. I have seen a cell become one-third filled with this precipitate after a few week's use.

This precipitate also softens and disintegrates the active material, and the apparent advantage of its use in preventing sulphating seems to be off-set by the disadvantages above mentioned.—Yours, &c.,

SAMUEL F. BARRY.

New York, July 25, 1889.

MODES OF DAMAGE BY LIGHTNING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Kindly permit me to ask Prof. Lodge to state the actual height of the church steeple at Wavertree, as it has an important bearing on the question of area protected by an efficient lightning conductor. That the conductor is efficient may, I presume, be taken for granted; but it appears to me that the points A and C in Fig. 1 (elevation of Mr. Lennox Peel's residence, *The Electrician*, July 12) may be outside the area of protection, as commonly accepted—viz., a cone, the finial point as apex, and radius of base being equal to the height of finial point. May not the damage to house roof, guttering, &c., have been caused by a direct stroke, which, owing to the lessening of atmospheric resistance caused by the approach of the charged cloud, was enabled to discharge itself through this path before coming within striking distance of the conductor?

Of course I do not offer this as an original idea, but there does not appear to be any circumstance mentioned in Dr. Lodge's report antagonistic to this old theory.

The fusion of gas pipe in cellar may also be due to this discharge.

If, however, the fusion was not caused by an electrical discharge jumping from or to the pipe at point of fusion, but was caused by the same disturbance which caused the luminous display on the drive, might it not be due to either a direct stroke received by the conductor on steeple, or the heavy induced currents, or rather waves, which would probably be surging in the conductor? It is probable that the whole of the

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pipe system in the vicinity would be affected; that the ball of fire travelling up the drive was merely the luminous discharge given off from the gas pipe; and that the fusion of pipe in cellar was due to a fault in the same, it having been partially cut by a gas hook, perhaps (if lead), or having heated at a white-leaded screwed joint (if iron). Or it may be that this was the weakest point, conductively (if I may coin a word), and therefore gave way.

Allow me to put on record the following instance of a luminous discharge:—

The Manchester Racquet and Tennis Courts, situated in New Blackfriars-street, has a brick shaft rising from the centre of the block of buildings, and supporting an iron ventilating pipe, some 12in. or 14in. in diameter and 45ft. long; a 6ft. elevating rod and five point finial is fixed on the ventilating shaft, and a seven-strand half-inch copper rope is carried down by the side of the iron pipe, and is lashed to the latter at intervals of about 5ft.; at the bottom of shaft the rope enters the ground, and is carried some 70ft., terminating at the main branch water pipe. About four years since I happened to be walking down New Blackfriars street and noticed a brilliant blue, lambent light surrounding the finial points, and apparently extending some four to six inches in every direction around each of the five points.

There was at the time a background of dense black cloud, extending from the horizon about 45deg., and another dark cloud bank coming up. A thunderstorm had passed over an hour or so before. I watched this brush discharge for about twenty minutes, when it gradually disappeared, occasionally brightening up, then again fading, till at the expiration of half an hour or thereabouts the approaching storm broke, with a prelude of a few heavy drops of rain. I saw no more of the discharge after this, though I waited till the storm was nearly over, hoping to see the conductor receive a lightning discharge, but was disappointed.

The lightning was exceedingly vivid, and was accompanied with heavy peals of thunder, and the storm was directly overhead, or in the immediate vicinity, flash and peal being apparently simultaneous. I have omitted to state that the luminosity was so intense that the points were imperceptible for about half their length (6″ points, as usual, with an 18″ central point) and that it had the appearance of St. Elmo's fire as seen on the yards and rigging of an iron ship, except that the edges appeared to be of a reddish-yellow tinge; but this was probably owing to smoke from adjacent chimneys passing across the line of vision.

With reference to Colonel Fraser's report on the Mangalore Lighthouse disaster, I cannot agree with him that "the earth connection must have been complete."

Two hundred feet of cable, laid on an insulator (rock), even though wet with heavy rain, would form but a poor "earth."

Allow me to quote an instance of the insulating virtue of rock—porous wet sandstone. I fixed a lightning conductor on a boiler chimney, belonging to Messrs. Emmott, of this city. The conductor was of 1in. by ⅛in. copper tape, entering the ground (tipped stuff on substratum of red sandstone) at the base of chimney, and extending some 70ft. to the river Irwell; a copper plate 2ft. by 1ft. being rivetted and soldered to the tape and sunk in the river.

A copper plate, 1ft. by 1ft., was buried in the ground, at about 6ft. from the river bank, and 5ft. deep, to form a testing earth; but on testing, the earth resistance was found to be over 2,700ω; a second testing earth was formed by burying a similar plate flat on the substratum of sandstone, and covering it with a bushel of coke, well settled down with soil and water, but still the R was over 2,700ω; how much over I am unable to say, as I had not the means available of measuring any higher resistance.

The fact that water offers a high resistance appears to be too frequently overlooked. Compared with rock, of course, it is a good conducting medium, but by itself, without the admixture of earth of some kind, it is a poor conductor. If Dr. Lodge or Mr. Preece would lay stress on this point, probably we should hear less of lightning conductors being "earthed" in slate cisterns, specially erected and insulated, evidently with the intention of drowning the lightning; or of brick sumps specially constructed and cemented to prevent the escape of water by percolation, so that the conductor may always terminate in this valuable, but greatly imposed on, fluid.

I must apologise for taking up so much of your valuable space. I had no intention of writing at such length, but the importance of and general interest taken in this subject must be my excuse.—Yours, &c. J. Lavender, Junr., C.E.

11, Todd-street, Manchester.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.

July 9, 1889.

11,018. D. G. Weems. London. Improvements in and relating to electric railways.

11,019. D. G. Weems. Improvements in and relating to electric railways.

11,032. J. Oulton and J. Edmondson. Bradford. Improvements in electric meters, parts of which improvements are applicable to clocks and timepieces.

11,046. W. P. Thompson. Liverpool. Improvements in cores for electrical apparatus and the method of forming the same (the Westinghouse Electric Company, U.S.A.)

11,049. J. J. Wood. London. Improvements in dynamo-electric machines, in part applicable to electric-motors.

11,067. C. T. Snedekor. London. Improvements in insulation for electric conductors.

11,070. J. Y. Johnson. London. Manufacture of elements or plates for secondary batteries (Andrew Lawrence Ricker, U.S.)

11,071. H. H. Lake. London. An improved method and apparatus for connecting carbon filaments to metallic conductors and for similar purposes (Hermann Lemp, United States).

11,075. S. C. C. Currie. London. Dynamo-electric machines.

11,082. C. H. Gardner, F. L. Rawson, and W. S. Rawson. London. Improvements in electric flashing lamps (partly communicated by Percy Scott, H.M.S. "Edinburgh").

July 11, 1889.

11,179. Siemens Brothers and Co. (Limited.) London. An electric meter (Firm of Siemens and Halske, Germany).

11,191. W. A. S. Benson. London. Improvements in roses for supporting electric lamps.

July 12, 1889.

11,242. Siemens Brothers and Co. (Limited). London. Improvements in dynamo-electric, magneto-electric, and electro-dynamic machines (Firm of Siemens and Halske, Germany).

July 13, 1889.

11,269. G. A. Nussbaum. London. Improvements in electric meters.

July 15, 1889.

11,315. A. W. Richardson. Manchester. An electric motor arc lam .

11,317. H. Whiteside-Cook. Stondon-Massey. A method of and apparatus for controlling steam and gas engines by means of electricity.

11,323. E. Correns. London. Improved grids or supporting frames of electric accumulators.

11,332. K. W. Hedges. London. Improvements in and in the materials used in the manufacture of brushes and commutators of dynamo machines in part applicable to bearing surfaces generally.

11,341. G. W. Walker and W. Bracken. London. Improvements in recording apparatus for electric meters.

July 16, 1889.

11,419. Siemens Brothers and Co. (Limited). London. Improvements in electric meters (Firm of Siemens and Halske, Berlin).

11,422. T. G. Litchfield. London. Improvements in and relating to bulbs or globes for incandescent electric lamps.

11,425. E. Fischinger. London. Improvements in regulating apparatus for electric arc light lamps.

11,426. P. A. Newton. London. Improvements in the mode of driving by means of electric motors, tram-car and other mechanism, and in apparatus for reducing in transmission the speed of rotation derived from electric and other motors (W. Main, United States).

11,429. P. M. Justice. London. Improvements in the manufacture of electric lamps (J. Clegg, United States).

11,430. P. M. Justice. London. Improvements in electrodes or filaments for electric lamps (J. Clegg, United States).

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July 17, 1889.

11,471. E. N. Reynier. London. Improvements in electric accumulators or storage batteries.

July 18, 1889.

11,501. P. Ward and E. M. Gregory. London. Improvements in the construction of electric fuses and detonators, and in the method of and appliances employed for manufacturing the same.

11,519. C. W. Farquhar and H. L. Doulton. Lambeth. Improvements in roses for supporting electric lamps.

July 19, 1889.

11,528. C. Beyer and G. Hagen. London. Improvements in electrode plates for electric accumulators.

11,574. W. J. L. Hamilton. London. Improvements in and connected with insulators, electrical conductors, and conduits for same, partly applicable for telpherage and other electric lines.

July 20, 1889.

11,581. N. G. Thomson. London. Improvements in electrical alarms.

11,589. R. E. B. Crompton. London. Improvements in electric conductors, and in laying and supporting conductors within conduits.

11,590. F. King and W. P. Mendham. Bristol. Improvements in primary batteries.

July 22, 1889.

11,636. P. Jolin. Bristol. Improvements in instruments for detecting and measuring electric currents.

11,661. C. Huelser. London. Improvements in thermo-electric and furnace batteries (H. Mestern, Germany).

July 23, 1889.

11,676. H. J. Allison. London. Station printing telegraphs, &c. (M. D. Porter, United States).

11,705. F. M. Engelbach and E. B. Bright. London. Appliances for economising and utilising surplus electricity for lighting, power, and other purposes.

11,732. F. Anderson. London. Improvements in and relating to electric telegraphs.

July 24, 1889.

11,755. J. Kent. London. An improved method in connection with arc lamps.

11,780. C. E. Buell. London. Improvements in electric generators.

11,799. J. E. Wright and J. Moore. London. Improvements in printing telegraphs.

July 25, 1889.

11,832. E. R. Dolby. London. Improvements in junctions or couplers for electrical conductors.

11,846. Siemens, Brothers, and Co. (Limited). London. Method of maintaining the constancy of electrical potential difference in the several branches of distributing network supplied with either continuous or alternating currents (the firm of Siemens and Halske, Germany).

11,847. Siemens, Brothers, and Co. (Limited). London. Improvements in the distribution of electric energy (the firm of Siemens and Halske, Germany).

July 26, 1889.

11,900. M. Dallas. London. An improved conduit for electric railways.

11,914. A. Reckenzaum. London. Improvements in the manufacture of plates for secondary voltaic batteries.

11,927. S. Pitt. London. Machine for covering electrical conductors (J. B. Atherton, United States).

July 27, 1889.

11,941. Mix and Genest (Limited) Co. and W. Oesterreich. London. Improvements in switch boards for telephone exchange.

July 29, 1889.

11,997. W. Emmott and W. Ackroyd. Halifax. Improvements in electric meters.

12,030. J. Holloway, W. R. Mortimer, and A. D'Romtra. London. Improvements in electro-magnetic apparatus for brakes and similar purposes.

12,035. G. Forbes. London. Improvements in electric meters and electric regulators.

SPECIFICATIONS PUBLISHED.

1888.

12,505. De Feranti. Joints for electric mains. (Price 8d.)

12,798. Vigil and Revueltas. Electric sounding apparatus. (Price 6d.)

12,907. Parker and Lowrie. Dynamo electric machines. (Price 11d.)

13,076. Jacob. Electrical signalling apparatus. (Price 8d.)

1889.

238. Gibbs and Fresquet. Dynamo electric machines. (Price 8d.)

2080. Lake (Stanley). Medical electric apparatus.

8,053. Imray (Jones and others). Electrical signalling. (Price 8d.)

8,861. Imray (Thompson). Electric switches. (Price 6d.)

9,192. Strode and Davis. Fitting for electroliers. (Price 6d.)

9,231. Heys (Clark). Regulating electric currents. (Price 6d.)

COMPANIES' MEETINGS & REPORTS.

The Cuba Submarine Telegraph Company (Limited)

The thirty-sixth ordinary general meeting of the Cuba Submarine Telegraph Company (Limited) was held at the Company's offices, No. 58, Old Broad-street, on Wednesday last, Mr. Alexander F. Low presiding.

The SECRETARY (Mr. James Scott) read the notice convening the meeting. The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: In moving the adoption of the report I have much pleasure in congratulating you on the nature of the results of the last half-year's traffic, which I am sure will be highly satisfactory to you. The receipts are £888 in excess of those of the corresponding period of the previous year, and £3,000 in excess of those of the corresponding period of 1887. The charges, I am sorry to say, are exceptionally high, caused principally by the expenditure of £1,600 in repairs on the Batabano-Cienfuegos cable; but the amount of money left at our disposal is sufficient for the payment of the interest on the Preference Shares, for the payment of a dividend at the rate of 9 per cent. on the Ordinary Shares, for placing £6,000 to the reserve fund, thereby increasing it to the good round sum of £90,000, leaving £345 to be carried forward to the current half-year. Since our last meeting we have been getting a number of messages from a French Company, who have established communication between Cuba, Hayti, and Venezuela, which we hope will go on increasing, and if so, we may expect that they will make up for the reduction we have made in our charge. We have had very serious complaints from the West Indian Colonies for a long time as to our high charge, and we have thought it incumbent upon us to make a reduction for transit messages. You will not be surprised to see by the report that we have come to the resolution of making an inroad upon the reserve fund by laying a duplicate cable between Batabano and Cienfuegos. This was the original cable laid in 1870, and it is now 19 years old, and, as you learn from the report, it is far from being in a satisfactory state. Therefore it is incumbent upon us as quickly as possible to duplicate it. We cannot now give an estimate of its cost, for Mr. Keith, who has been very much occupied upon the repairs, has not been able to furnish us with the probable length of the cable that will be required. We are, therefore, not in a position to ask for estimates for the new cable. The breakdown which occurred on the 13th of last month was successfully restored on the 27th. With these remarks I beg to propose—

"That the report and accounts for the half-year ended 30th June last, now submitted, be received and adopted."

Mr. THOMAS GREENWOOD seconded the motion.

Mr. COCHRAN: Will you kindly tell us what will be about the length of the new cable?

The CHAIRMAN: About 170 miles. It is the only cable we have had in that section. We have had three in the other—from Santiago to Cienfuegos. One of those was abandoned nine years ago, but the other two are in good working order.

Mr. GRIFFITH desired to know what had been the result of the last five weeks' traffic since the reduction in the rate took place?

The CHAIRMAN: We cannot answer definitely the question you have asked because we have only had a month's working, but I am happy to be able to inform you that the traffic for that month is estimated to produce within £80 or £90 of the amount we received from the traffic of July last year, so that there is very little falling off caused by the reduction of the rate.

Mr. HOOPER: What is the average reduction of the rate?

The CHAIRMAN: The principal reduction is on the transit messages from the West Indies. Our rate was 67 cents, and it is now reduced to 50 cents—a very considerable difference, but not more than the circumstances demanded.

Mr. HOOPER: Have the other lines made a similar reduction?

The CHAIRMAN: We were fortunate in making application to the International Company soliciting them to do so, and they reduced the rate on their line—not exactly so much as we did.

The resolution was then unanimously agreed to.

The CHAIRMAN then moved:—

"That the following dividends for the half-year be now declared upon the shares of the Company, viz., at the rate of 10 per cent. per annum, subject to income-tax, on the Preference Shares, and 9 per cent. per annum, free of income-tax, on the Ordinary Shares, payable on and after to-morrow."

Mr. GREENWOOD seconded the motion, which was carried unanimously.

The CHAIRMAN moved the next resolution as follows:—

"That Mr. Neil Bannatyne be re-elected a Director of the Company."

Mr. Bannatyne, he regretted to say, was suffering from illness, which prevented his attendance on that occasion; but that gentlemen expected to be able to resume his usual duties within a week or a fortnight.

The motion having been seconded by Mr. GREENWOOD, was carried unanimously.

Mr. C. W. PARISH proposed:—

"That Messrs. Gane and Jackson be, and they are hereby, re-elected auditors of the Company for the current year at a salary of 20 guineas."

Mr. HOOPER having seconded the motion,

Mr. BOVILL proposed as an amendment that only one of these gentle-

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men should be re-appointed, on the ground, as he contended, that then there would be no division of responsibility. He preferred to have the responsibility on the audit fixed upon an individual rather than upon a firm, because the shareholders in that case knew what they were doing.

Mr. GRIFFITH seconded the amendment, maintaining that the law had always a greater hold on an individual than on a firm.

After a brief discussion,

Mr. PARISH agreed to withdraw his motion in deference to the wishes of some of the shareholders, and the amendment was carried re-electing Mr. Gane as auditor.

The CHAIRMAN subsequently proposed a vote of thanks to the secretary, to Mr. Keith, the Company's engineer, and the members of the staff in London and in Cuba, paying a warm tribute to their zeal and efficiency in performing their various duties.

Mr. BOVILL having seconded the resolution, it was cordially carried.

The SECRETARY briefly acknowledged the compliment, remarking that it would be very gratifying to all concerned to know that their services met with the approval of the shareholders.

A vote of thanks was afterwards passed to the Chairman, who briefly returned thanks, and the proceedings terminated.

United River Plate Telephone Company (Limited).

The third annual ordinary general meeting of this Company was held yesterday at Winchester House, Old Broad-street, under the presidency of the Right Hon. Lord Thurlow.

The SECRETARY (Mr. J. Owen Unwin) read the notice calling the meeting. The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN: I shall now proceed to make a few remarks as is customary on the report, but I am thankful to say that the occasion does not call for very many words from me. We appear before you again with what I think you must admit is a highly satisfactory balance-sheet, with one solitary exception, and that solitary exception, which is the key to the small dividend which we are able to declare, is the loss on exchange. That is a circumstance which is absolutely beyond the control of the Board. It has been unprecedentedly high, and of unprecedentedly long continuance, but we hope that in the future it will not occur again to the same extent. At the same time, this is so very serious a subject that I think you will pardon me for referring to it, as it absolutely absorbs on the present occasion 5 per cent. of the subscribed capital, so that instead of meeting you and being able to recommend a dividend at the rate of only 3 per cent., if it were not for this very unsatisfactory item, which shows a loss on exchange of £14,689, we should have had it in our power to offer you 8 per cent. in addition to the 3 per cent. already paid. This is a grievous state of things, and it behoves the Board to do what they can to make sure that this item does not recur—at any rate to the same extent—in succeeding years. Throughout the duration of last year our attention has been drawn to it, and we have always been hoping that the loss would be somewhat mitigated during that period, instead of which, as you all know, it has been constantly aggravated as time went on. It will be necessary for us to take steps to provide against its recurrence. Of course, there are two ways of meeting it, but neither of them should be attempted without very mature consideration. The one is the raising of the rates to subscribers, and the other is the adoption of a system of partial payments in gold and paper currency, because it is obvious that if we were paid half in gold and half in currency, the one would act as a counterpoise to the other. The matter, though ripe for consideration, cannot be decided hastily, and I am very glad to be able to say that we shall have the advice and experience of Mr. Fels, who has just returned from the River Plate, and who is in this room to-day. He arrived from Buenos Ayres the day before yesterday, but has not yet had time to give us the benefit of his views on this point. But you may take it for granted that we shall lose no time in consulting him and adopting whatever means we may think wise to mitigate at any rate this loss in future. There is another point I wish to draw attention to in connection with our dividend. We now give 3 per cent. in addition to the 3 per cent. which has been already paid, making 6 per cent. per annum, and I wish to say one word by way of comparison with the report we issued last year. Last year's report represented a period, as you know, of sixteen months, and for that period we paid 7 per cent. If you examine that carefully you will find that the 7 per cent. for 16 months is only 5¼ per cent. for 12 months, so that on the present occasion in offering you 6 per cent. for 12 months we are giving you ¾ per cent. more than for the corresponding period last year. Now, I must ask to say a few words upon our general business, which I am glad to say is in a highly satisfactory condition at the present moment. The Company commenced with 3,150 subscribers in Buenos Ayres. That figure has been raised by rather more than 50 per cent., which I think is extremely gratifying. In addition to that there is this feature, which I consider is no less satisfactory, namely, that there is an almost absolute cessation of complaints, and there is a general satisfaction expressed on the part of those we serve. That is a point to which we attach very great importance. We have supplied from the commencement a service of a very high standard of excellence, and much higher than people in Europe are accustomed to receive. I want to say one word about our sales business, which you may remember in the original prospectus was estimated to bring in a profit of £4,000 a year. That estimate has been more than doubled, which I regard as a satisfactory feature, and one that is likely to continue. As regards working expenses they have been unduly raised to a higher figure than they would have stood at by the occurrence some months ago of a very severe storm or cyclone. Although storms and hurricanes may be matters of frequent occurrence in the River Plate, still the one I refer to was of such unusual severity as to do very great damage to our system of wires, and from first to last it has caused an additional expenditure to us of something like £2,000 to repair the damage. Notwithstanding that, taking into consideration our increased number of subscribers, our working expenses do not stand at a higher figure than they did for the previous 12 months. I feel sure that you will be anxious to know a few details with regard to the Rosario business which we have acquired. Rosario is one of the most promising places from a commercial point of view: those who know it best anticipate for it a most prosperous future. There were two companies there, and we were exposed, as I think you know, until we purchased the second one, to great competition. Well, we entered into an agreement for the purchase of this opposition company, and I am thankful to say that the negotiations were carried out in an amicable spirit, and resulted in our obtaining the business at, I think, a very fair and reasonable price. We have now acquired the service of that company, and have installed in the united business at Rosario a very competent manager, who, I believe, is giving universal satisfaction. The number of subscribers has largely increased—not to 50 per cent., but, I should say, to something like 40 per cent.—during the past six months, and there is every prospect before us of a great improvement, so that instead of having anything to regret by the acquisition of the property, we may fairly congratulate the shareholders on the arrangement having been satisfactorily carried out. I believe that the acquisition of the property and the absolute control that it gives us over the telephonic arrangements of that rising town and the towns surrounding it and growing up along the line of railway between it and Buenos Ayres—along which, as time goes on, we shall undoubtedly lay a trunk line—I say that that circumstance has done more to consolidate our position and our power over the telephonic industry throughout the whole of the Argentine Republic than any other step that we could have taken. There is one satisfactory feature in the past year that I ought to allude to, and that is that, thanks to various circumstances, we have been enabled to get into the closest touch with our business on the other side of the world. This is greatly due to the presence here in the early part of the year of Mr. Krabbe, our consulting director at Buenos Ayres: he came over to England for a well-earned holiday in the latter part of last season and stayed with us for several months, attending our meetings and giving us the benefit of his experience. He has now returned to Buenos Ayres, where he has practically undertaken the supervision of our business—at any rate during the absence of our competent manager, Mr. Fels, who is here to-day. I am glad also to be able to tell you that two of your Directors have at different times during the year visited the River Plate—Mr. Coghlan and Mr. Le Rossignol. The former is unfortunately not able to be here to report on his visit, having been ordered abroad for the benefit of his health, but I am glad to say Mr. Le Rossignol is with us, and I hope he will address to you a few words explaining the satisfactory condition in which he found matters in Buenos Ayres when he left it but a few weeks ago. Thanks to all the circumstances to which I have referred, thanks to the energy displayed by Mr. Fels and by Mr. Krabbe in the management, and thanks to the successful acquisition of the business in Rosario, I believe that our present position leaves really nothing to desire except that the prosperity which we enjoy should continue. But I would ask you to believe that the business of this Company at the other side of the globe cannot be conducted from London by responsible directors without a considerable amount of ceaseless anxiety, and there are circumstances attached to telephonic business to which I venture to think the argument I venture to use is especially applicable. That anxiety, I am glad to say on the present occasion, has been greatly mitigated by two circumstances, one at home and the other abroad. These two circumstances—I hope I may be pardoned for saying so—have made this responsibility sit lightly, or more lightly on our shoulders than it would otherwise have done. One has been the knowledge that we have in our office in London a secretary and manager, Mr. Unwin, in whom we can not only place the utmost reliance for the due performance of the details of our business, but in whose wisdom and experience of South America we have the greatest confidence; and I have already referred to Mr. Krabbe and Mr. Fels for their assistance at Buenos Ayres. Without the feeling that we can rely absolutely on the gentlemen that assist us in this enterprise, I can assure you that it would be almost impossible to manage a business of this description and magnitude at the distance that London is from Buenos Ayres. The Chairman concluded by moving the adoption of the report and accounts for the last twelve months.

The DEPUTY-CHAIRMAN (Mr. J. Irving Courtenay) seconded the motion.

Mr. ALFRED LE ROSSIGNOL then gave a brief account of his recent visit to Buenos Ayres, where, he said, he found everything connected with the Company in a most satisfactory condition. The business had been very rapidly developed there, and was likely to still further increase, as might be inferred from the gradual increase to their list of subscribers. In the course of four or five years the town had advanced by 50 per cent. Buildings were being continually erected in the streets and squares, and the Company's prospects were very bright. The telephone was more in use there than in England, owing to the absence of good roads and to the faulty postal arrangements, Rosario he had not time to visit, but he believed that that town was developing more rapidly than Buenos Ayres; it was becoming the Chicago of the Republic.

Mr. THOMAS LLOYD, lately a director, then addressed the meeting, criticising the action of the Board with regard to the Rosario and Montevideo businesses.

Mr. J. T. LAWRENCE asked several questions respecting the accounts to which

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The CHAIRMAN replied, while, in reference to Mr. Lloyd's remarks, he defended what the Board had done with regard to Rosario and Monte Video.

The resolution adopting the report and accounts was then put and carried unanimously.

The CHAIRMAN then proposed the re-election of Mr. Frank W. Jones, Mr. George Cooper and Mr. Alfred Le Rossignol as Directors.

Mr. LAWRENCE seconded the motion, which was agreed to *nem. con.*

On the motion of Mr. LAWRENCE, seconded by Mr. TURNER, the auditors, Messrs. Cooper Bros. and Company, were re-appointed.

Mr. DUNCAN then proposed a vote of thanks to the Chairman and Directors, whom he congratulated on their stroke of policy in securing the Rosario business.

Mr. KINGSBURY expressed his agreement with Mr. Duncan's views and seconded the motion, which was carried unanimously.

The CHAIRMAN having returned thanks, the proceedings terminated.

The Anglo-American Brush Electric Light Corporation (Limited).

An extraordinary general meeting of the shareholders of the Anglo-American Brush Electric Light Corporation (Limited) was held at the office of the Corporation, 112, Belvedere-road, Lambeth, on Wednesday last, the Right Hon. Lord Thurlow in the chair.

The SECRETARY (Mr. E. Garcke) having read the notice convening the meeting,

The CHAIRMAN said that in consequence of intervening holidays and other reasons it was found impossible to complete the formalities connected with the registration of the new company by the date of the present meeting, and as it was not advisable to confirm the resolutions passed at the previous extraordinary general meeting to wind up voluntarily the Corporation until the new company was registered, he had to move—

"*That the meeting be adjourned until the 14th of August, at the offices of the Corporation, at 3 o'clock p.m.*"

The DEPUTY-CHAIRMAN (Mr. R. P. Sellon) seconded the resolution.

A SHAREHOLDER raised the question whether it would not be in the interest of the body of shareholders to alter the place of meeting to the Cannon-street Hotel.

The DEPUTY-CHAIRMAN said it was merely a question of expense.

The CHAIRMAN said that they stood now in a position that they never occupied before. The whole industry was looking up—in fact, trade was reviving all round—and there was no reason why they should not derive some share of the general prosperity. But unless they had succeeded in forming an amalgamation of this description so as to put them on equal terms with the other manufacturing companies, they would inevitably have fallen into the background and ceased to occupy the prominent position with regard to electric lighting which they had always held. He had no objection, if he received a substantial number of requests on the part of shareholders, to hold the meeting on the following Wednesday at Cannon-street Hotel. As the Deputy-Chairman said, it was purely a matter of expense.

The resolution was then unanimously agreed to, and the proceedings terminated.

Aluminium Company (Limited).

The report of the Directors of this Company, which was submitted to the shareholders at the meeting at the Cannon-street Hotel on Wednesday, referred with regret to the results of the year's working, which had not answered the anticipations expressed by the Directors at the last meeting. After referring to some of the causes which had contributed to this state of affairs, the Directors attributed some of their trouble to the fact that aluminium bronzes are now made by electrical processes; and that although, as the Directors considered, these processes are much inferior to those manufactured by the Company, they are much cheaper, and are preferred by those who are making experiments with these alloys. The Directors have experienced difficulties in the process of manufacture, but they stated that these difficulties had been completely overcome.

At the meeting, Mr. GERALD W. BALFOUR, M.P., who presided, went largely into the question of the difficulties which had arisen in the manufacture by the Company of aluminium. They had been under the impression that the metal turned out by the Company would be pure enough to meet all commercial requirements, but had found that the French workers in the metal, who were the principal users of it at the present time, were not satisfied with its quality and preferred French manufacture to theirs, although they had to pay a higher price for it. He was happy to say that their difficulties had now been overcome by the discovery made by Mr. Castner for the purification of the chloride, which relieved them from all further trouble on this point. The invention was of extreme value to the Company, and had been patented. So great was the success attained by the new process that they could now make aluminium not only superior to the French, but with a purity of something like 1 per cent. over the metal made in France. The Chairman further alluded to the extreme competition in the aluminium market, which had seriously affected the Company's income, and had seriously disorganised the market. So far as the production of pure aluminium was concerned, the Company already stood in a position of advantage over all its rivals. With regard to the alloys, however, he did not think they were in so favourable a position. Alloys made by electrical processes were no doubt inferior to theirs—they were inconstant in quantity and were not to be depended upon, but they were cheaper than anything the Company could afford to sell. He could only hope that time, which was undoubtedly on their side, would give them the opportunity of ousting these inferior alloys. He referred to inventions which they had every reason to expect would result from experiments now being carried on at their works, and in particular he gave it as his opinion that the invention of Mr. Castner would not only lead to most successful results, but that the Company would shortly be in possession of a process which would place them above the fear of any competition, and that thereby they would be able to command the market for alloys as well as of the pure metal. He hoped that within a fortnight or three weeks they would know exactly how they stood with regard to these experiments, which were being carried on at Mr. Castner's expense, but which, if successful, would become the property of the Company on terms which had not been finally settled in detail, but which would make Mr. Castner's remuneration only dependent on the profits made. With regard to the financial position of the Company, he had every reason to hope for the best.

Sir HENRY E. ROSCOE, M.P., in the course of a few remarks, agreed with the Chairman that their difficulties had been extremely great, but through the skill and ability of Mr. Castner and the chemists on the spot, they had overcome them. They were in possession of new and valuable patents by which the metal could be prepared in a state of absolute purity, and they were now able to make it in any quantity.

The retiring Directors and auditors were re-elected, and a vote of thanks to the Chairman terminated the proceedings.

Keswick Electric Light Company (Limited).

On Thursday last week at the Court Buildings, the statutory and first ordinary meeting of the shareholders of this Company was held under the presidency of Mr. R. D. Marshall, of Castlerigg Manor.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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Mr. JAMES FAWCUS (Messrs. Fawcus and Cowan, of Chester), the Managing Director and engineer, *pro tem.*, read the following report:—"I have much pleasure in giving you a report of the progress of your undertaking. The Directors have accepted the tender of Messrs. Johnson and Phillips, of Charlton, S.E., to supply all the necessary electrical machinery and instruments for the equipment of the central station at Forge, also to supply and lay down the mains and to provide a number of transformers for the conversion of the high tension current to a low tension at the consumers' houses. The dynamos and transformers will be Kapp's patent. Messrs. Johnson and Phillips, from the high position they occupy in the electrical world, may be depended upon to turn out thoroughly satisfactory work, and they are at present engaged on the construction of one of the large central stations now in progress in London. The large alternator will be driven by a turbine giving a high efficiency. This turbine is being supplied and erected by Mr. Frederic Nell, of London. The Directors consider that to guard against any temporary shortness of water owing to exceptional drought, frost, or other causes, it will be desirable to instal a steam engine and boiler as spare gear, which will be able to work the station in the event of any stoppage of water from these causes. They will accordingly, if possible, make arrangements to provide them. Plans have been prepared of the generating station and machinery in position, which are now before you. The contractors for the electrical and mechanical machinery have undertaken to have their work in running order by the 1st of October, and it is expected that the buildings will be ready for them by this time. Messrs. Johnson and Phillips are under contract to run the central station for a month after completion at their own expense, before handing it over to the Company, when it must be in thorough working order and to the entire satisfaction of the Company's engineer."

The election of the Board of Directors for the ensuing year resulted in the re-election of the Provisional Directors, Mr. R. D. Marshall, Mr. J. J. Spedding, Dr. Knight, and Mr. W. Wilson (Keswick Hotel), with the substitution of Mr. John Birkett for Mr. Fawcus, who was appointed engineer.

NEW COMPANIES REGISTERED.

D. HULETT AND CO. (LIMITED).—This company was registered on the 30th ult., with a capital of £35,000, in £5 shares, to carry on business as lamp manufacturers, brass and iron founders, mechanical, gas, hydraulic, and electrical engineers, and manufacturing chemists; also to take over, as a going concern, the business of D. Hulett and Co., of 55 and 56, High Holborn. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, £500 in shares or stock; the company in general meeting will determine remuneration.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended August 2, 1889, amounted to £5,525, as compared with £5,601 last year.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this Company for the month of July, 1889, were £3,000, as compared with £3,086 in the corresponding month of last year. The receipts for the month of April, estimated at £4,000, realised £4,060.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of July, 1889, amounted to £1,677, as compared with £1,518 last year.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company for the month of July, 1889, amounted to £24,800. From the 1st January to 31st July, 1889, they were £154,200, against, in the corresponding months of 1888 and 1887, £156,000 and £150,520 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 2, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,916, as compared with £4,673 last year.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The traffic receipts of this company for the half-month ended July 31, 1889, amounted to £2,690, as compared with £2,857 last year.

ELECTRICAL AUTOMATIC DELIVERY BOX.—A petition by this company for the usual winding-up order came before Mr. Justice Kay on Saturday last, Mr. Marten, Q.C., appearing for the petitioner. He said the company was registered in January, 1888, when there was an agreement existing for the purchase of certain patents for £30,000—£10,000 in cash and the remainder in fully paid-up shares. The company did not commence business, because it was found that all the ground on which business could be profitably carried on was already occupied by other companies. On the appointment of a new board in January last negotiations were entered into with the vendor, and his purchase money was reduced from £30,000 to £7,150. The directors found, however, that there was only £1,000 in hand, and that it was perfectly useless to attempt to carry on business. The idea was that 2,000 machines should be erected, but they had only six, and they could not find any places where they could be profitably utilised. There were about £200 unpaid calls, and £1,700 uncalled capital; there were also the patents, which were of problematical value. Under these circumstances, the capital being inadequate, and there being no chance of carrying on business at a profit, the directors asked for the usual winding-up order. Mr. Renshaw, representing shareholders, supported the petition. Mr. Justice Kay made the order required.

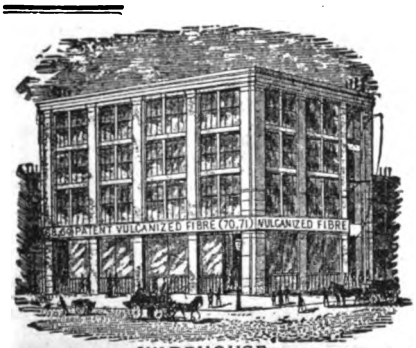
THE ELECTRIC APPARATUS COMPANY.—On Monday last a petition presented by the company to continue the voluntary winding-up under the supervision of the Court came before Mr. Justice North, in the Chancery Division of the High Court of Justice. Mr. Higgins, Q.C., who appeared for the company and two creditors, said the company was registered on February 23, 1884, its object being to carry on the business of wholesale and retail dealers in electrical apparatus. The nominal capital of the company was originally £12,000, but only £3,750 had been called up. The business of the company had recently become unprofitable, and in the month of July of this year, the company not being able, by reason of its liabilities, to continue business, at an extraordinary meeting, and upon due notice, a resolution was passed in the ordinary form that the company be wound up voluntarily, Mr. Friend, the secretary of the company, being appointed liquidator. The company was indebted to its bankers and sundry trade creditors in upwards of £1,500. It was expected that the assets, independently of the goodwill, would be enough to pay all the creditors. Mr. Cozens-Hardy, Q.C., who appeared for Mr. Montague, said he did not object to a supervision order, but submitted there ought to be a reference to Chambers to appoint an independent liquidator. After some discussion it was arranged that the voluntary winding-up should be continued upon the terms that if Mr. Montague's debt was not paid off within three months he was to have liberty to apply in Chambers for the appointment of a new liquidator, the company undertaking not to enter into any contract for realisation of the goodwill without giving Mr. Montague seven days' notice.

RAILWAY ELECTRICAL CONTRACTORS (LIMITED).—Mr. F. E. Hersee, of 144, Leadenhall-street, E.C., has been appointed liquidator of this company.

SCHMIDT DOUGLAS ELECTRIC COMPANY.—Two petitions to wind up this Company came before Mr. Justice Chitty, in the Chancery Division of the High Court of Justice, on Saturday last. The petitions were presented by creditors in respect of goods sold and delivered. The company admitted the debts, and that it was not able to pay. Counsel asked that one order might be made on both petitions, as the second one was presented without knowledge of the first. His Lordship made one order on the two petitions.

DISSOLUTION OF PARTNERSHIP.—It is announced that Messrs. E. H. Harling and C. B. Aird, trading as electricians under the name of Messrs. Harling, Aird and Co., of 7, Railway-approach, London Bridge, S.E., have dissolved partnership.

THE NON-CONDUCTOR OF ELECTRICITY.



WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

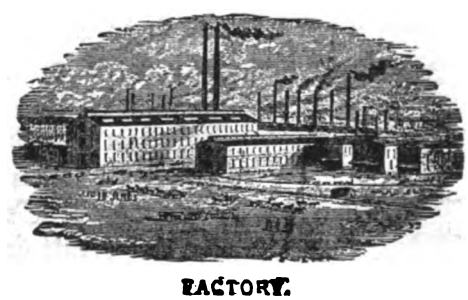
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Aug. 7, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Aug. 7, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	2½%	Anglo-American ..... xd	52¼ 53¼	3 14 1	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	5%	Do. Preferred ..... xd	88 89½	4 7 7	,, ,,	89⅜	88
2,614,820	Stock	...	Do. Deferred	18 18½	...	February	18	...
130,000	£10	10%	Brazilian Submarine	13 13½	5 3 8	Mar., June, Oct., Dec.	13¼	...
112,900	£100	5%	Do. 5 per Cent. Bonds..... xd	101 103	4 16 0	January and July ...	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	..	...
16,000	10	9%	Cuba Submarine	15 15⅜	5 17 10	February and August	15 5/16	15⅛
6,000	10	10%	Do. Preference 10%	20 21	4 17 6	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3½ 4	...	March & September	...	...
6,000	5	10%	Do. Preference 10%	8¾ 9½	5 5 3	April and October ...	...	...
60,710	20	3½%	Direct United States	10⅜ 10⅝	5 1 5	Jan., Apr., July, Oct.	10⅞	...
380,000	10	5%	Eastern ..... xd	13½ 13¾	4 15 7	,, ,,	13⅝	13⅜
70,000	10	6%	Do. 6 per Cent. Preference ..... xd	15 15½	3 17 5	,, ,,	15⅝	15¼
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock ..	108 110	3 12 9	May and November.	109½	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899 ..... xd	106 109	4 10 1	February & August	108⅞	108⅛
250,000	10	5%	Eastern Extension	13¼ 13½	4 15 5	Jan., Apr., July, Oct	13⅜	...
320,000	100	6%	Do. 6 per Cent. Debentures, 1891..... xd	102 104	3 18 1	February & August	103	102½
473,000	100	5%	Do. 5 per Ct.(Austrln.Gov. Sub.) Debs. 1900 ...	102 105	4 14 4	January and July ...	104⅛	103⅜
179,177	10	6%	Globe Telegraph and Trust	8¼ 8⅜	4 15 9	Jan., Apr., July, Oct.	8 1/16	8⅛
178,992	10	6%	Do. 6 per Cent. Preference	14⅞ 15⅛	3 19 4	,, ,,	15⅛	14⅞
150,000	10	7½% for '88	Great Northern.....	14⅜ 15¼	4 12 4	Jan., July, and April	15⅜	15⅛
17,000	25	15%	Indo-European	40 42	6 1 6	April and October ...	...	...
9,000	8	5%	Reuter's	6¾ 7¼	5 10 2	April and October ...	...	...
15,609	10	3/0	West African Telegraph.....	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
30,000	10	6% for '88	West Coast of America	10 10½	..	January and July ...	10¼	10
150,000	100	8%	Do. Debentures 8%	124 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 2⅜	...	...	2 1/16	...
34,563	10	12/0*	Do. 1st Preference 6%	11⅞ 12¼	...	April and October ...	12 1/16	11⅞
4,669	10	†	Do. 6 per Cent. 2nd Preference..	14 15	...	...	...	...
45,181	15	6%	Western Brazilian	10⅜ 11¼	6 10 4	March & September	11	..
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	7%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅛ ⅜	4 8 3	...	...	...
80,000	5	25%	United.....	15⅛ 15⅝	5 12 11	June and December	15⅛	15⅜
55,000	5	3/0	United River Plate.....	5⅜ 6⅛	...	January and July ...	6⅛	6
			ELECTRIC LIGHT.					
23,003	5	..	Anglo-American Brush (£4 paid)	3⅛ 3⅜	...	...	3⅛	...
23,692	5	...	Do. (fully paid)	4⅛ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	4⅜ 4⅝	...	...	4⅝	4 7/16
			MISCELLANEOUS.					
87,350	12	30/0	Telegraph Construction and Maintenance	43 45	5 6 3	March and July.....	45	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works ...	19 20	5 0 0	February & August	19⅜	19⅛

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIDUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
J. G. Statter & Co., Limited.

3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 587.—Vol. XXIII. FRIDAY, AUGUST 16, 1889. Price Fourpence.

NOTES.

Yesterday afternoon the Electric Lighting Provisional Order Bills were read a third time in the House of Lords and passed. Lord Crawford, in the concluding discussion, stated that although much pains had been taken in framing these Orders, the testing and meter clauses were unworkable—an opinion which we ventured to express at the time the Model Order was published.

The summary extinction which the Westminster Syndicate has suffered at the hands of the Select Committee of the House of Lords cannot but remove any lingering doubt which may exist as to the importance of the local inquiries held under the Electric Lighting Acts of 1882 and 1888. Had the Westminster Syndicate taken Major Marindin's inquiry a little more seriously, and put in an appearance there as "persons locally interested," the fact that they had spent a large sum of money on machinery, and were actively engaged in electrical distribution would, we feel sure, have had considerable weight with the Inspector, especially if, as their counsel implied, they had only been prevented from applying for a Provisional Order by reason of their being registered eleven days too late. As it was, the Syndicate choose to allow the Westminster Electric Supply Corporation to fight its way to the House of Lords before entering into the field against them, and the Committee, very properly we think, held such belated opposition to be unreasonable.

In spite of the pathetic and by no means unnatural appeal of the St. James's and Pall Mall Company to be granted at least two years' peace and quiet in the area covered by their license, the Select Committee decided to allow the London Electric Supply Corporation to maintain their existing foothold in the district. This decision is noteworthy as demonstrating that the Legislature, as well as the Board of Trade, is no believer in the efficacy of "potential competition," but intends to carry out Major Marindin's suggestion of bringing, wherever possible, two companies using different systems of distribution into immediate competition.

We recently indited an article on "Alternate-Current Working," which, although by no means intended to be controversial in character, drew from Mr. Swinburne (*see* our last issue) a rejoinder, in which he maintains that the "old theory of synchronism" stands in need of no modification whatever. For our part we have not the least desire to impeach Dr. Hopkinson's mathematics, but we still venture to believe that the conditions of the problem are, to say the least, not fully expressed in the formula he has given us. Dr. Hopkinson can easily afford to be less than infallible. Mr. Swinburne apparently thinks that he cannot.

If Mr. Swinburne be justified in his assertion that the old theory is not only "perfectly clear," but is also competent to explain all that needs explanation, how comes it to pass we may fairly ask that this same theory, as interpreted by Mr. Swinburne himself, pointed not long ago to conclusions some of which we now know to be hopelessly at variance with the facts? To particularise only some few instances out of several at hand, did or did not Mr. Swinburne (*circa* 1887-9) draw the following deductions from the theory in question?:—

1. That coreless armatures would only run parallel with no load. (*Journal* Institute Electrical Engineers, XVII., 401.)
2. That with such armatures it would be necessary to make up for the lack of self-induction by putting iron elsewhere in the circuit. (*Journal* Institute Electrical Engineers, XVII., 401.)
3. Did he not lay great stress, so recently as March last, on a device of his own which was to solve the problem by the application of an "induction-coupler?" (*Journal* Institute of Electrical Engineers, XVII., p. 401; XVIII., p. 221.)
4. That with a parallel constant E.M.F. system of supply the use of such synchronising motors was incompatible with efficiency. ("Practical Electrical Measurement," p. 152.)
5. That such motors would not work well with varying load. ("Practical Electrical Measurement," p. 152).

Would it not be as well if Mr. Swinburne would now explain which, and how many, of these assertions he still holds by? For our part we are prepared to traverse them all.

So much for the *argumentum ad hominem*. Let us now consider briefly the essence of the controversy, which, we take it, turns upon the question whether or not Dr. Hopkinson's formula of 1884 expresses fully the necessary and sufficient condition for the parallel working of alternators. This, we need scarcely remind our readers, amounts to saying that the time-constant

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L/R must bear a certain fixed ratio to the periodic time of the current. Now in Mr. MORDEY'S Paper he stated that *he thought* his machines would synchronise equally well at any periodicity, and we happen to know that this has since been confirmed by experiment. This is a most important point. Unless Mr. SWINBURNE is prepared to show that in this machine the value of L (which our correspondent is fond of assuring us is a variable) varies inversely with the speed, we are at a loss to imagine how he can possibly continue to maintain his present views. On another main issue, that of the nature and extent of the *rôle* attributed to self-induction, and apart from its relation to the periodic time, Mr. SWINBURNE has also to explain how it comes to pass that whilst the actual behaviour of the machine is entirely dependent upon the value of the impressed field, the value of the self-induction coefficient is scarcely affected by any variation which the field may be caused to undergo. He will probably allow that when there is no impressed field synchronism is impossible. Yet even in this case L has been shown to be nearly unchanged. Here, then, is another problem waiting for Mr. SWINBURNE'S elucidation in terms of the old theory. It seems to us that on these points Mr. MORDEY'S views were quite clearly set forth in his recent paper and reply. But Mr. SWINBURNE concludes his letter somewhat illogically by remarking that he really does not understand what Mr. MORDEY'S opinions are. We venture to recommend our correspondent to make a further effort to master this side of the argument before he continues his attempts to upset it.

BEFORE leaving the subject, we have just one word to say upon Mr. SWINBURNE'S controversial style. Epigrammatic and facile as it undoubtedly is, we think he would do well to sacrifice some of its superficial brilliancy in order to obviate a certain air of precocious omniscience with which his utterances are somewhat painfully pervaded. For so young a man the extent of Mr. SWINBURNE'S practical and theoretical knowledge of physical science does him infinite credit, but he really has no sufficient title to deliver his views with all that tone of contemptuous infallibility which, in his weaker moments, he so much affects. "People," Mr. SWINBURNE tell us, "have been hopelessly confused by one of Mr. MORDEY'S experiments, and most of the conclusions drawn from it must be reversed to have any meaning." We shall not trouble ourselves to contest this assertion, but we do seriously think that when Sir WM. THOMSON and Mr. KAPP are the only "people" who so far have publicly drawn any conclusions from the experiment in question, Mr. SWINBURNE (if only out of consideration for their maturer years) should try to be more gentle in his mode of controverting their opinions. It will be seen from what we have said that our difference with Mr. SWINBURNE is not so much in respect of his present interpretation of the Mordey experiments, but in what we consider to be his unjustifiable assumption that he has known all there was to be known, at least since 1887, and that there is nothing new to be learnt from recent investigations. In the unpopular days of science the customary series of assertions with which new discoveries were greeted was, first, it is not true; second, it is not new; third, we knew all about it years ago. We are sorry to see Mr. SWINBURNE posing in this ungraceful and antiquated attitude.

WE are gratified to notice that an attempt is being made during the present naval manœuvres to remedy a glaring defect in the programme of previous operations. Last year we drew attention to the manifest disadvantage at which the defenders were placed in consequence of there being no adequate means of communication between the signalling stations on land and the friendly fleet off the shores; and we pointed out how easily the much-needed system of signalling might be established. We do not know whether our suggestion has been acted upon, but we happen to know that one of several naval signalling officers who have in the interval been trained in Morse telegraphy is now on board H.M.S. "Hercules"; and it is from this vessel that the experiment, reported in Monday's *Standard*, of signalling by flash of lamp, in Morse code, to Prawle Point, was successfully accomplished. About midnight, at two miles distance, the "Hercules" flashed the messages by dots and dashes, "Machinery working very satisfactorily. Report to Lizard."

SIGNALLING from ship to shore is, however, of little use, unless the message can be forwarded on to the neighbouring naval and military stations, a fact which was brought to light on more than one occasion with painful emphasis during the last naval manœuvres. Thanks to Admiral TRYON, who subsequently reported on this matter, the authorities have organised a system which during the present operations will, according to the *Standard's* correspondent, enable every signal station on the coast to give prompt information to the military and naval depôts in its district of the movements of any hostile fleet approaching our shores. As permission has this year been given to call out the regular and volunteer forces in the threatened localities, it is probable that the Royal Engineers have been at work connecting the coast stations with the main land lines. From a notification in this week's "Post Office Circular" it would appear that 28 coastguard stations have been connected telegraphically with their nearest postal telegraph offices. Much to our surprise, the full list of these places is given—and will be no doubt promptly communicated to Admiral BAIRD'S attacking fleet!

WE report in another column some interesting and important information as to the actual cost of working the Brussels electric tramways with Julien accumulators, as given by M. MICHELET, the Director of the Tramway Company, the figures being based on two years' experience. The cost of working the same lines with horses is estimated at 25 centimes per car-kilometre, and the cost of the electrical system, *exclusive* of the maintenance of stationary machinery, royalties to the inventors, interest upon the capital, and depreciation of plant, but including the cost of maintaining the accumulators, comes out at the same figure. But as the horse-car estimate includes stud renewals, electrical working shows a serious loss. It must, however, be remembered that the Brussels lines are not only run over steep gradients, but are also badly laid, so that the batteries were

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tested somewhat severely. We have never yet been convinced that accumulator traction can be economically worked except when the conditions of the service are of a favourable character. We shall, however, be interested to hear further reports from America, where, so far, the Julien system appears to have done much better.

THE subjoined information is taken from an electrical journal which appears weekly in one of the Western States of America. We have no doubt that our readers will feel thankful for its preservation :—

The "ohm" is named after a Professor Ohm who invented it as a standard or unit of measuring the resistance to an electric current in its transmission through a body, usually a wire. A volt is the standard or unit of electromotive force. European electricians call it an "element." It is the parts of which an electric battery is constructed, and consists of plates of zinc, copper, or prepared carbon, which are immersed in a liquid. A battery consists of a number of volts, the number varying with the strength of the electric current to be generated. The term "volt" is formed from the same as Volta, the Italian scientist whose name is prominently connected with the development of electric science.

Interruption of the New Zealand Cable.—We are officially informed that telegraphic communication with New Zealand is interrupted.

Kilmarnock.—At the monthly meeting of the Kilmarnock Town Council last week it was agreed to oppose the application of the Scottish House-to-House Electricity Company.

Teignmouth.—The Teignmouth Local Board have decided to send a reply to the Devon and Cornwall Electricity Supply Company to the effect that they oppose their application.

Bangor.—Notice has been received from the Midland House-to-House Electricity Company of their intention of applying for a Provisional Order to enable them to supply Bangor with the electric light.

Berlin.—A fire broke out recently in the electrical section of the Machinery Hall in the Exhibition of Apparatus for the Prevention of Accidents. The central division of the section was destroyed, but the fire was prevented from spreading.

Telegraphic Communication with Obock.—It is officially announced that telegraphic communication has been established with Obock on the Red Sea, the cable having been laid by the Eastern Telegraph Company's cable steamer "Chiltern."

The Edison Patent in Canada.—Our readers will probably remember that a decision was recently given in the Canadian Courts upsetting the Edison lamp patent. This decision has now been set aside by the Superior Court and the case will be re-tried.

Paddington Vestry.—At a meeting of this vestry last week the Clerk reported that a valuable report on the question of the electric lighting of the district was being framed by the committee appointed for that purpose, and that it would be ready for presentation after the recess.

The Birmingham Exhibition.—A fire occurred at the Electrical and Industrial Exhibition last week, the prompt extinction of which was due to the efficient action of the electric fire-alarms, which have been erected in the hall in connection with the exhibits of Mr. Julius Sax.

Folkestone.—The Corporation on Thursday last week fixed the official seal to the contract of Messrs. Crompton and Co. No less than five companies have intimated their intention to the Town Council to apply to Parliament for powers to supply the electric light to private consumers in the town.

Warrington.—At the meeting of the Warrington Town Council last week it was reported by the Gas Committee that they had instructed the Town Clerk to oppose the applications, of which notice had been given by three electric light companies, for power to supply the borough with the electric light.

Lynton.—The Lynton Local Board have decided to accept Mr. Green's terms for lighting Lynton, Lynmouth, and the main road between the two places by electricity. The Valley of Rocks, Lyndale, Torr's Park, and Crown Hotels, and several shops and private residences, are also to be lit with the electric light.

The Post Office Magazine.—*Blackfriars* is this month a capital number, most of the articles being entertaining and well written, the one by Mr. H. Badcock, relating some curious correspondence of savings' bank depositors with the Post Office, being especially noticeable for its lively humour and grace of style.

Overhead Wires.—On Thursday last, in answer to Sir G. Campbell, Mr. Ritchie said that in some cases local Acts have been passed which empower the authorities to make by-laws on the subject of overhead wires. With the exception of these cases local authorities are not enabled to make by-laws on the subject.

Sheffield.—In reply to the notice of the Electric Construction and Maintenance Company, the Improvement Committee of the borough have recommended the Council not to give consent to the granting of a Provisional Order, on the ground that the Council may probably themselves seek to obtain powers necessary for the purpose.

Peterborough.—Two companies have served notices on the Corporation of their intention to apply for Provisional Orders to supply Peterborough with electricity. The Corporation, however, have refused their sanction, and have instructed the surveyor to prepare a scheme for the supply of electricity by the Corporation within the borough.

Ayr.—The Ayr Town Council intend to apply for a Provisional Order to enable them to light the streets and town buildings by electricity. The water of the dam at Ayr mills will, it is thought, be sufficient to supply the motive-power for the dynamos. A report will be submitted by the Council before any steps are taken in the matter.

Dublin.—At the meeting of the Dublin Corporation on Monday last, the report of the special committee recommending that application be made for sanction to the borrowing of £50,000 to carry the electric lighting scheme into effect, and also that the committee be empowered to acquire a site other than Island Bridge, was read a first time.

St. Helen's.—At the last quarterly meeting of the Town Council, notice having been given by two companies that they intended to apply to Parliament for a Provisional Order authorising the supply of electricity within the borough, the Gas and Lighting Committee recommended the Council to apply for a Provisional Order to enable them to supply electricity for public and private purposes in the borough. This was agreed to.

Holborn Board of Works.—At the meeting of this Board, on Monday, the Committee of Works recommended that the Board consent to a license being granted to the Gwynne-Pilsen Company to supply electricity in the Holborn District, subject to the company obtaining an Order from the Board of Trade similar to the Order granted to the Metropolitan Electric Supply Company in regard to the district. The report was adopted.

Gent and Co.'s Catalogue.—This catalogue is mainly devoted to electric bells and similar apparatus, and contains concise instructions as to running and testing wires and setting up batteries. The illustrated list of bells, pushes, and electrical alarms is very complete, and a large number of pages is also allotted to electro-medical and surgical apparatus. We notice, amongst other things on this list, a useful pole indicator and Hick's glass bead hydrometer.

Lincoln.—A monthly meeting of the Lincoln Urban Sanitary Authority was held on Tuesday last week. The Lighting Committee reported that they had received a notice from the Midland House-to-House Electricity Company and the Electric Construction Company of their intention to apply for powers to supply electricity to the city. The Committee recommended the Council to oppose the schemes. The Council confirmed the action of the Committee.

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John Fowler and Co.—The revised catalogue issued by John Fowler and Co., of Leeds, numbers some 70 pages, and contains an exhaustive list of engines adapted to electric lighting and other purposes. We are glad to notice that this firm have given up the use of the misleading term nominal horse-power, and now designate the different sizes by letters specifying the actual power the engines give off at the pressure and speed mentioned in the price list.

Fenton.—At the last meeting of the Fenton Local Board, the Clerk reported that he had received notices of intended applications for Provisional Orders from the Municipal Electric Light and Power Corporation and the Midland House-to-House Electricity Company. It was considered that the interests of the Board would be affected by such a course, and the Clerk was instructed to take the necessary steps to place the Board in a position to oppose the application.

Exports of Electrical Apparatus.—The following table, taken from the Board of Trade returns, shows the values of the exports of telegraphic wires and apparatus connected therewith during July and the first seven months of the year, in comparison with the corresponding figures for the previous two years :—

	1889.	1888.	1887.
Month of July ...	£32,909	£21,571	£195,950
Jan. 1 to July 31..	609,365	265,784	384,762

Dundee.—On Wednesday last week, at a meeting of the Dundee Gas Commissioners, the Committee on Electric Lighting recommended the Board to apply for a Provisional Order, and also to intimate to the parties concerned that the Commissioners would oppose any similar applications by speculative companies. The recommendation was approved of, and a Committee was appointed for the purpose of gathering information in regard to the electric light.

Severe Thunderstorms.—On Wednesday, last week, a farm servant at work in an open field near Driffield was struck by lightning and killed. On Sunday last the Midlands and the North were again visited by destructive storms. At Birmingham considerable damage was done to property, but no fatal accident occurred. At Nottingham the Roman Catholic Chapel was struck by lightning, and the bell turret was damaged. At York, on the same day, several individuals were injured, and some houses were partially wrecked by lightning.

Arc Light Photometry.—The question of the actual candle-power of the lamps in the Unter den Linden lighting having been raised, Prof. Slaby was requested to go fully into the matter, and his results with numerous curves for candle-power in various directions are given in a lengthy Paper in the *Verhandlung des Vereins zur Beförderung des Gewerbfleisses*, No. 4, 1889, which will well repay perusal by those interested. An abstract at some length is given in the *Electrotechnische Zeitschrift*, No. 13, 1889.

Halifax.—At the last meeting of the Electric Lighting Committee of the Halifax Town Council, the Town Clerk submitted notices from the Electric Construction and Maintenance Company and the Yorkshire House-to-House Electricity Company of their intention to apply for Provisional Orders. The Town Clerk was instructed to inform the companies that as there were already two companies supplying electric light with the permission of the Corporation, any application for Provisional Orders by the above-named companies would be opposed.

Bradford.—At the meeting of the Bradford Town Council, on Tuesday last, Alderman F. Priestman, in moving the adoption of the proceedings of the Gas and Electricity Supply Committee, said that the arrangements for the installation of the electric light were now practically complete, and within the next week probably the members of the committee would have an opportunity of witnessing a test of the installation. The installation would be handed over to Messrs. Siemens for six weeks in accordance with the terms of their contract, after which the Corporation would take the matter into their own hands. After September 1st the contracts for the supply of the electric light would come into force.

The Tabor Indicator.—We have received from Messrs. J. Musgrave and Sons, of Bolton, an excellent little handbook relating to the Tabor Indicator, and containing a number of tables which should prove of great use to those connected with steam engines. The chief feature of the Tabor Indicator is the method employed to give a straight line motion to the pencil, a stationary plate containing a slot, the curve of which just compensates the tendency of the pencil point to move in a circular arc, being used to guide the motion of the pencil bar.

Leith.—The report of the General Committee of the Leith Town Council upon the notices received from the Brush Company, the Electric Construction and Maintenance Company, the Scottish Electric Supply Company, and the Scottish House-to-House Electricity Company, was read at the last meeting of the Corporation and approved of. It was to the effect that the Council should decline to give its consent to the intended applications, and that it should act in conjunction with the Edinburgh Town Council or Gas Commission to oppose such application.

The Edinburgh Exhibition.—At the last meeting of the Executive Committee of the forthcoming Exhibition, it was unanimously agreed to fix the title of the Exhibition thus :—"The International Exhibition of Electrical Engineering, General Inventions, and Industries, Edinburgh, 1890." The guarantee fund was reported to have already reached £5,000. It was arranged to send a deputation to London to endeavour to see Mr. Edison this week to make definite arrangements as to his exhibits. The site at Merchiston, consisting of about 40 acres, has been definitely settled upon.

Arbroath.—At a meeting of the Committee of Management of the Gas Corporation on Friday last, a letter was read from the Scottish House-to-House Electricity Company, giving notice that they intended to apply for a Provisional Order, and asking the consent of the Gas Corporation to their application. It was unanimously agreed to recommend to the Police Commission and Gas Corporation not to give their consent to the application, and to forward a request to the Board of Trade for time to consider the needs of the community in respect to lighting, and the desirability of the Board applying themselves for a Provisional Order.

Plymouth.—The result of the canvass of Mr. Bingham, engineer of the Devon and Cornwall Electricity Supply Company, is that over three thousand incandescent lights have been definitely ordered for various shops, private establishments, and public places. The number of applications received being so satisfactory, arrangements are being made to proceed with the work without delay. The plant to be laid down in the first instance will be sufficient to supply 4,000 incandescent lights and 1,000 arcs, and when this has been ordered no further engagements will be entered into until additional plant is introduced.

Torsion in Silk Fibres.—The Munich Institute of Physical Research has published some figures comparing the torsion of a silk fibre with that of a platinum wire ·004 millimetre (0·16 mils). The breaking strain of the wire was 97 grammes, that of the silk fibre 36 grammes. The torsion was determined by suspending a small magnet with a mirror in the earth's field, first by the wire and then by the fibre, the upper end being fastened to a torsion head, which was turned round until a given deflection was produced on the scale. The results obtained show that the silk fibre is about 200 times better than the platinum wire.

Derby.—At the meeting of the Derby Town Council on Wednesday last week the Parliamentary Committee reported that they had considered the question of lighting the town with electricity. They did not consider that a scheme for the lighting of the whole town by this means would at present be prudent, but, at the same time, they were of opinion that a modified scheme for public and private purposes was highly desirable, and that the time had arrived when the Corporation should move in the matter. They therefore recommended that authority should be given to them to make the necessary application to Parliament.

Safety Insulating Staples.—The old-fashioned iron staple hammered in tight against electric light and bell wires, cutting the insulation and frequently fracturing the conductor itself, has long been an abomination in the eyes of those who like to

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see good work in every detail of an installation. The "safety insulating staple," made of specially-prepared insulating material, which is being introduced into this country by Messrs. Mosses and Mitchell, of Chiswell-street, is therefore likely to have a wide sale if it can in any way compete in price with the old article. We may mention that these insulating staples are the only ones used on board the ships of the United States Navy.

The Edison Lamp Patents: Important Decision.—The National Company for the Distribution of Electricity by Secondary Generators writes us as follows:—"We have just received the following cablegram from Mr. George Westinghouse, junior, of Pittsburgh, U.S.A., the contents of which may interest your readers:—'Decision yesterday, Judge Wallace, in United States Court, in case conducted by Edison Company, construing Supreme Court decision, holds American patent expires with prior patent abroad, even when void for failure to work or pay taxes. This decision overthrows high-resistance carbon filament patent, main reliance of Edison Company for maintaining monopoly incandescent lighting in United States.'"

Davey, Paxman & Co.—We have received from Messrs. Davey, Paxman and Co., of Colchester, a copy of the revised edition of their well-known catalogue. The publication, which is admirably illustrated throughout, contains full details with regard to the numerous types of engines and boilers manufactured by this firm, including portable and semi-portable, vertical and horizontal, high-pressure and compound engines, and Cornish, Lancashire, multitubular, "Essex" vertical, and "Economic" safety boilers. The catalogue also contains illustrations of Davey, Paxman and Co.'s electric light shed at the Colonial Exhibition and of their fine plant at the air-compressing station in the Rue de St. Fargeau, Paris. The information given in this publication is of a very complete character, and it should be of great value to all those who wish to purchase high-class engines and boilers.

Orleansville (Algeria).—The contract for the erection of a central-lighting station at Orleansville, to which we referred some time back, was obtained by MM. Gally and Daloz, and the installation is expected to be in working order within the next few weeks. Six kilometres outside the town there is an hydraulic station comprising a 70 horse-power turbine and two 35-ampere 500-volt dynamos connected in series. The central station in the town will contain a Babcock and Wilcox boiler, a Weyher and Richemond engine, a Desroziers-Bréguet dynamo giving 110 volts and 250 amperes, and 350 accumulators of the Planté type. In the daytime the accumulators will be charged in series by the dynamos at the hydraulic station, and discharged in parallel at night. The steam plant is intended to serve as a stand-by in case the water should fail. The town lighting will require 250 16 candle-power lamps, which are to be hung in the middle of the streets in groups of three; the plant is capable of supplying 600 lamps. Overhead bare copper wires are used throughout.

An Electric Reading Lamp on the Automatic Principle.—Passengers by the main line of the South-Eastern Railway will henceforth have the benefit of an electric reading lamp, with which the company's carriages are being equipped. The apparatus is contained in a small box, five inches by three, which is placed immediately under the rack, and over the passenger's head. By the introduction of a penny at the top of the box, and the subsequent pressure of a knob, a five-candle power light is obtained, which will burn for half an hour and then extinguish itself automatically. The light may be continued for an indefinite period by the renewed insertion of a penny every half hour. A special feature of the invention is, we are glad to learn, that if the apparatus should happen to be out of order, the penny will drop right through and deposit itself in such a way at the bottom of the box that it may be recovered, the same result being obtained if a half-penny or other coin not of the size of a penny be inserted. One accumulator to every carriage supplies the current to the whole number of lamps in each compartment.

Manchester.—At a special meeting of the Manchester City Council on Wednesday last week the question of an application by the Corporation for a Provisional Order came up for discussion. Alderman Lamb, chairman of the Gas Committee, in moving that a Provisional Order be applied for, said the Gas Committee were not in opposition to the electric light or any other invention that could be shown to be for the public good. Alderman Sir J. Harwood regretted that there was not a more encouraging past to go upon, and said that the position of the Corporation, if it obtained powers, was a very serious one, inasmuch as every person residing within the zone applied for could compel the Corporation to supply them within three years. He was sorry the application could not be deferred. Alderman Asquith pointed out that unless the Corporation took action, the half-dozen companies already in the field would get powers and supply the light. The Mayor said the risk incurred was not immediate. They had three years to turn round in, and they could defer it for some time at all events. They were not obliged to at once commit themselves. The resolution was then put and carried unanimously.

The Waring and Tatham Underground Cables.—We have received from Mr. Richard Waring, of Queen-street, a pamphlet containing a description of the Waring Underground Cable system and numerous testimonials from various users in the United States. These lead-covered cables, which were fully described in *The Electrician* of November 2, 1888, are favourably known for their durability and high insulation under trying conditions. In the lighting of the Hoosac Tunnel (Mass.), for instance, Waring cables were finally adopted after several kinds of special insulation had succumbed to the excessive moisture and sulphureous fumes. The Fowler-Waring Cables Company (Limited) has now been formed to undertake the manufacture in this country both of this type of cable and of Tatham's lead-covered cables, which are in use on the City and Southwark Subway, and which are at present supplied by the well-known engineering firm of Fowler and Co. (Limited), of Leeds. Under the present rearrangement, and in view of the immense prospective requirements for underground cable work in this country, we can only anticipate a prosperous future for the new company. We understand that the share capital was already more than covered on Wednesday last. The lists close this day (Friday) at noon. A full prospectus of the new venture will be found in our advertising columns.

The Paris Meeting of the Institution of Electrical Engineers.—The following circular, giving an outline programme of the arrangements for this meeting, has been issued to those members who have signified their intention of attending:—On Friday evening, August 23rd, a joint meeting of the Institution and the Société Internationale des Electriciens will take place at the rooms of the Société, 44, Rue de Rennes (Place St. Germain des Près), at half-past eight, when the members will be received by Colonel Sebert, President of the Société, who will inaugurate the proceedings by delivering a short address of welcome. This will be followed by addresses from Sir William Thomson as President of the Institution, and Monsieur Mascart, President of the Paris International Electrical Congress, 1889. Various instruments and apparatus will be exhibited, including Carpentier's "Melophone," Edison's "Improved Phonographs and Telephones in communication with the Opéra," &c. A lecture will be delivered, at a date to be fixed hereafter, at the Central Electrical Laboratory, by Prof. Joubert, on "Hertz's Recent Investigations," when most of his experiments will be reproduced. M. Abdank-Abakanowicz will lecture, with full experimental illustrations, on Elihu Thomson's latest Electrical Investigations, including his Electric Welding process. On subsequent days, which it is not desirable to fix until the Congress at their first meeting (August 24th) have settled the days and times for *their* meetings, the following works of interest will be visited:—Messrs. Sauttier Lemonnier's Works; Messrs. Menier's Cable Works; the Telephone Society's Construction Works; the Central Electrical Laboratory; the Central Electric Lighting Stations at the Palais Royal, the Rue Druot, the Grand Opéra, and the Eiffel Tower. We learn that members, associates, and students of the Institution of Electrical Engineers to the number of 123 have announced their intention of taking part in the Paris meeting of the Institution. If anything like this number actually attend, the meeting ought to prove a decided success.

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M. LEBLANC ON ALTERNATING MOTORS

(*Continued from page 346.*)

M. Leblanc continues at great length in *La Lumière Electrique* his Paper on Alternating Motors. In the later chapters much space is occupied with mathematical investigations, whose positive value is not, perhaps, very great, since the actual conditions of the problem are not very closely represented by the formula employed. Our author's speculations are, nevertheless, frequently ingenious and suggestive, even when they are not wholly novel, nor at present practicable. What here follows must be taken rather as an informal *résumé*, interspersed with some comments of our own, than as a cut-and-dried abstract of the original. M. Leblanc, we may add, is not easily abstracted, because he wanders up and down in his subject in a somewhat promiscuous manner.

On leaving the Mordey "commutating" motor (to which, however, he again returns) the author enters upon an "Investigation of the means of avoiding the apparent increase of resistance due to the phenomena of self-induction in circuits traversed by an alternating current."

He mentions three principal methods—

1. If in two branches of the same circuit having coefficients of self-induction L and L', the current has the values I and I' respectively, we may endeavour so to arrange matters that the sum

$$L I^2 + L' I'^2$$

shall maintain a constant value.

2. A second circuit (or a branch circuit) may be caused to react upon that in which we wish to reduce the impedance, in such a manner that the electrical inertia of the joint system is very small, approximating to zero.

3. We may intercalate a condenser of such proportions that the sum of the potential energy due to the inertia of the circuit ($\frac{1}{2} L I^2$) and of the potential energy stored in the condenser ($\frac{1}{2} K P^2$) may be constant.

M. Leblanc next considers how far these several methods are capable of practical realisation. (1.) If we knew how to employ oscillatory currents of short period (say, 4×10^6 oscillations per second, such as Hertz and Lodge are familiar with), the first method could readily be tried. The wave length of such oscillations would be about 1 metre, and it would merely be necessary to provide two identical sets of apparatus in which the active part of the circuit A is displaced one-quarter wave length in respect of the circuit A'. Then, at any instant t, the current in A may be represented by

$$I = J \sin 2\pi \frac{t}{T},$$

where J is a constant, and at the same moment in circuit A' the current is

$$I' = J \cos 2\pi \frac{t}{T}.$$

It follows that the potential energy of the system A A', if L be the self-induction of each circuit, is given by

$$L (I^2 + I'^2) = LJ^2 \left(\sin^2 \frac{2\pi t}{T} + \cos^2 \frac{2\pi t}{T} \right) = L J^2,$$

which is a constant (if L be constant).

"It will, therefore, be possible," says M. Leblanc, "to suppress the increase of resistance due to self-induction by employing currents of very high period." We must confess that in the light of our present knowledge this idea seems to us to be hopelessly chimerical; even if the practical difficulties of generating such rapid current waves in an available form were overcome the author still overlooks the fact that the peripheral distribution of currents of one metre wave length in the cross-section of the conductor would cause an increase of resistance which would probably be fatal. M. Leblanc does, however, recognise that his idea is not immediately available, and he is content to claim credit for priority of the conception.

(2.) The author attacks the second method by means of a mathematical investigation covering many columns of type, the upshot of which is that the condition to be aimed at is expressed in the following equation:—

$$T^2 R R' + 4\pi^2 (M^2 - L L') = 0,$$

where R R' may be the resistance of the armature and field magnets respectively, L and L' their coefficients of self-induction, and M the coefficient of mutual induction. Now, if the period T be small the first term may easily become negligible; we have then to make $M = \sqrt{L L'}$. This is, of course, equivalent to the condition that the armature and the field-coils shall possess the same magnetic circuit, in which, moreover, there is to be no leakage. It is easily seen that this condition is unattainable in a motor where the presence of a moving part necessitates an air-gap, though in a transformer it is very nearly realised. It is also evident that in practice the value of M will, as a rule, vary with the displacement of the armature. M. Leblanc shows, however, that the more nearly $M = L = L'$ the more nearly will the work done under an E.M.F. of given mean value approximate to the value of the work done in the same circuit by the equivalent continuous E.M.F., and he also shows that the internal work lost in the armature is the same in each case. M. Leblanc is here, however, tacitly assuming that L and L' are constant for all values of the current, and that M is of the same value for all positions of the armature—neither of which is strictly true; but we shall see how he proposes to circumvent these difficulties. As to the possibility of realising this ideal M. Leblanc proceeds as follows:—"Let us suppose that the armature (*circuit mobile*) is composed of a large number of similar coils, connected in the usual way with a Gramme commutator.* Let us arrange a pair of brushes to bear upon the commutator at two points so chosen that the closed circuit thus formed shall have a coefficient of self-induction equal to that of the field coils (*circuit fixe*), so as to satisfy the above relation. If we displace the armature by an amount corresponding to the interval between two commutator bars it furnishes an element of work, ΔW, which has been evaluated above.† But immediately, by the action of the commutator, the initial state of things has been restored (M has returned to the value M_1), and this without the expenditure of energy. The same operation being repeated indefinitely it will be seen that the machine will behave very nearly as if the current were continuous."

M. Leblanc then describes in outline a machine in which he hoped actually to embody these principles. It may be roughly described as a Siemens' alternator, with iron in the cores of the bobbins, and with the depth of the coils considerably extended in the direction of the pole-pieces. There are only six coils in the armature, and the commutator bars are separated by insulation of equal width. A single pair of brushes is made to bear upon the commutator in the usual way, but instead of being joined up to the external circuit they are directly connected together. The main current traverses the field-magnet circuit alone, and in this respect the motor resembles the Tesla and the Elihu Thomson types. For complete success everything depends in this case upon the equivalence of the self-induction in the armature and the field, upon the suppression of magnetic leakage, and particularly upon the lines generated in the armature traversing the iron of the field *in all positions of the armature* in preference to short-circuiting through air over the top of the coils. It would seem that these requirements must be excessively difficult to carry out, and also that the machine, when built, must necessarily possess some highly inconvenient features. M. Leblanc has, however, constructed or modified a Chertemps machine upon this plan, and with a current of 140 alternations he found that it "yielded an output proportionate to its size;" when, however, the period was shortened so as to give 300 alternations per second, the armature could not pass the dead

* The armature being, however, of the Siemens' alternating type.

† The value of ΔW is shown in the original to be

$$-\frac{E_0^2}{2(R+R')^2} \frac{M_1 \Delta M}{L},$$

where M_1 is the initial value of M. This can be made to approach as nearly as we please (on the lines already laid down) to the work done under similar conditions with a continuous E.M.F. of value $\frac{E_0}{\sqrt{2}}$.

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points. As, however, the machine had only six pairs of poles and six armature coils, we should have been inclined to think it well-nigh impossible to maintain M even approximately constant. However this may be, the impedance was found to be greatly diminished when the circuit of the brushes was closed, quite in accordance with the theory above given. The author thinks that the Desrozier disc armature (described in *The Electrician* of October 19th, 1888, p. 762) would be well suited for this class of motor; and although "difficulties of construction," which are not further particularised, but which can easily be imagined, have induced him for the present to abandon the idea, the author still thinks, upon the whole, that at least from the theoretical point of view this solution is the best yet indicated. Those of our readers who read the description of M. Leblanc's latest motor in our last issue will recognise that he has since embodied the idea of balancing the field lines by the self-induction of the armature in a somewhat different and apparently a more successful form.

(To be continued.)

THE PARIS EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT).

August 12, 1889.

The Thomson-Houston Exhibit.

The Thomson-Houston Company have made a fine exhibit, which is larger than at first sight it appears to be, as it is somewhat scattered. Dynamos of different types, and varying from the largest to the smallest size manufactured by the Company are shown at their stand in the main avenue of the Palais des Machines. In the United States section of the Agricultural Court about nine machines are running for the purpose of transmission of energy, and two double-motor tramcar trucks are shown in the railway section.

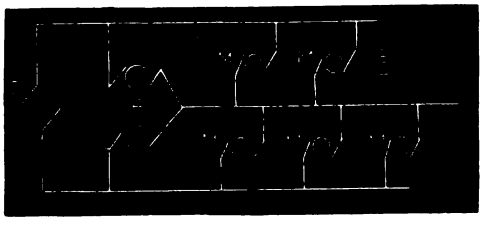

FIG. 1.

To anyone passing down the main avenue the most conspicuous object in the stand is the dynamo employed for the transmission of energy. It is the largest generator made by the Company, and gives 125 amperes and 500 volts. It has a drum armature, and the field-magnets are compound-wound, the shunt coils being wound in the usual way, and the series coils being fixed on to the extremities of the pole-pieces close to the armature, the two limbs being joined in parallel. From this machine the current is carried away to the Agricultural Courts on the Quai d'Orsay, about a mile from the stand. Here is a large shunt-wound motor of similar type and size to the generator, which drives a large dynamo of the well-known "Thomson-Houston" pattern. The current from this dynamo is supplied at a potential difference of 250 volts, and passes through a "potential equaliser" before reaching the motors, which are five in number. The "potential equaliser" is a machine somewhat resembling a shunt-wound motor in outward appearance, it has two separate sets of coils on the armature with two commutators and a pair of brushes to each. The theoretical connections will be understood from the diagram (Fig. 1). D is the Thomson-Houston dynamo, P the potential equaliser, M the motors. Although not the largest in point of horse power, this exhibit is one of the most interesting examples of the transmission and subdivision of energy by means of electricity to be seen in the Exhibition.

To return to the Palais des Machines. Four dynamos are constantly running to supply current for the various arc and incandescent lamps arranged round the stand and for the experiments with alternating currents shown at Prof. Elihu Thomson's personal exhibit in the Industrial Court. The largest of these machines is a 35-lighter of the well-known Thomson-Houston type, supplying energy for the arc lamps which are connected up in series with groups of incandescent lamps and arranged about the stand. The steadiness of the former is shown to advantage by this arrangement. Alternating currents are generated by two machines whose

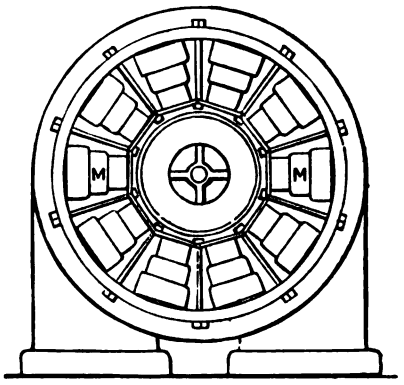

FIG. 2.—Thomson-Houston Alternator.

general form is shown in the sketch Fig. 2. In outward appearance they resemble one another, but differ considerably in the mode of exciting the field magnets. The circular framework (Fig. 2) with its internal pole pieces is cast in one piece. The armature is in the form of a cylinder built up of insulated rings, and the coils which consist of one layer only are placed flat on the outside and bound down in the usual way with insulated bands of wire. The spokes or spiders are set at an angle so as to act like a fan, causing a constant stream of air through the centre when running. The spindle is hollow, collecting rings are

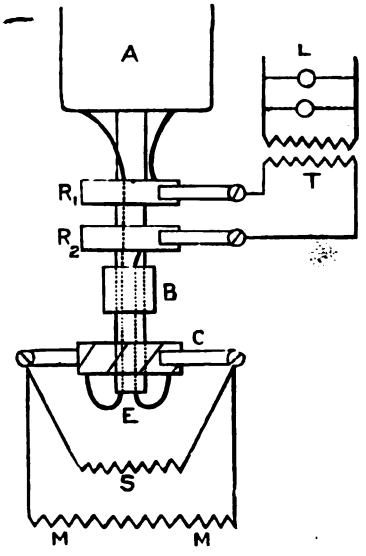

FIG. 3.—Diagram of the Connections of the Thomson-Houston Self-exciting Alternator.

placed on the inner side of the bearings next the armature and the commutator outside at the end of the spindle. The armature of the ten-pole machine, which is entirely self-exciting, carries two sets of coils laid over one another, one set being connected to the collectors and supplying the outside circuits, the other set being joined up to the commutator and feeding the field-magnet coils. The machine gives 20 amperes at a potential difference of 1000 volts, and is employed to run sets of 40 incandescent lamps in series. The eight-pole machine exhibits a different method of field-magnet winding; it

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might be described as an alternating-series dynamo partially separately excited. The connection will be easily understood on reference to the diagram Fig. 3. The current on leaving the armature A passes from the collecting ring R_1 to the outside circuits through transformers T, it then returns to the dynamo, entering by the other collector R_2, and flows through the hollow spindle to the commutator C, that is outside the bearings B. From here it passes as a continuous current round to opposite field-magnet coils, in series, M M Figs. 2 and 3, and returns to

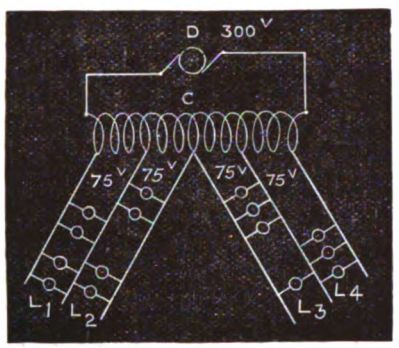

Fig. 4.

the armature by the hollow spindle. It is found necessary to shunt a small portion of the total current that would otherwise flow through the coils M M, ; this shunt is determined in the workshop and fixed in a convenient corner on the bed plate. The remaining coils of the field magnet are excited from another small machine, driven by a belt from a pulley on the end of the dynamo spindle outside the larger one, round which runs the belt from the main shafting.

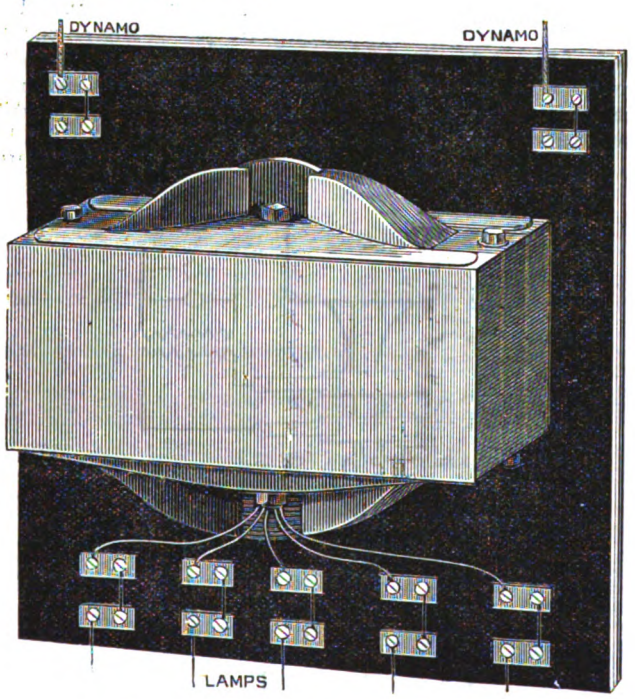

Fig. 5.—Thomson Houston Compensator.

The current from this machine is supplied at 300 volts, and is usually worked in connection with a "compensator." The theoretical connections of this arrangement are shown in Fig. 4. In Fig. 5 one of these "compensators" is shown fixed to a switch-board. The "compensator" consists of one continuous coil, surrounded by iron, as in a transformer, and connected to the dynamo. At equal intervals branches are led off for the lamps, as shown in Fig. 4. The circuits L_1 L_2 form one three-wire system, with lamps of 75 volts; L_3 L_4 form another similar system, with lamps of the same voltage.

The holder used for the incandescent lamps in series is fitted with a film "cut-out." In Fig. 6 we have a sketch of this arrangement. The leads are inserted through the top, and fixed to the terminals on either side of the circular brass frame F, Fig. 6. The central screw, W, is connected with one of these, and carefully insulated from the framework. The bent copper strip, C, is also attached to W, and prevented by the film of paper, P, from making contact with the frame. The other terminal, T, is in contact with the frame, F, and the flat spiral spring, S, which maintains contact with the other terminal through the copper strip at C, when no lamp is in the holder. On screwing in the lamp the ring R R presses S away from C, and thereby inserts the carbon between the terminals. If the lamp should go out the full pressure of the circuit is for a moment brought to bear on either side of the film P, which punctures, and the circuit is completed. Four or five extra lamps are arranged on the switch-board with a special switch, so that one of them can immediately be switched into the circuit by the engineer in charge when the instrument on the board indicates an increase of current, which results if one of the lamps in the series is cut out. This system is, of course, intended for street lighting or other installations where all the lamps are required at the same time.

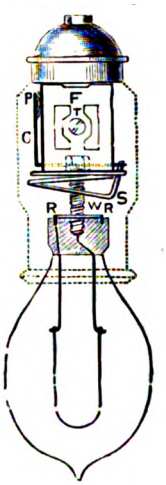

Fig. 6.—Thomson-Houston Lamp-holder for Series Circuit.

The double-motor tram-car trucks exhibited by the company in the railway section show the general form used on their electric tram lines. They differ slightly in one or two details. The latest form of suspending the motor is shown in Fig. 7, where projecting pieces from the motor M rest on an iron bar supported on large india-rubber washers, W, fixed to the iron frame F, instead of being fixed to a board resting across the framework of the truck. It is greatly to be regretted that the company had not an opportunity of exhibiting one of their tramcars in full working order, as it would have given the public a chance of trying a form of locomotion with which we are by no means too familiar on this side of the Atlantic.

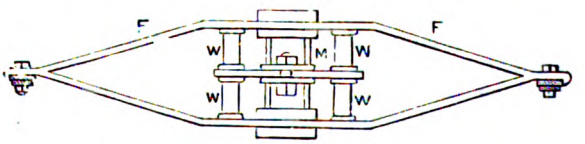

Fig. 7.—Thomson-Houston Method of Suspending Tramcar Motors.

The exhibit of the Thomson-Houston Company, under the management of Mr. Parsons, is practically separate from that of the Thomson Welding Company, which occupies part of the same stand, and which will be noticed at another time.

August 14, 1889.

The last meeting of the Conseil Municipal was almost entirely devoted to electricity. At the commencement the Conseil was occupied with the reading of a rather long report of M. Sauton relating to the present state of affairs, and giving the names of all the streets in which, up to now, underground mains have

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been authorised, and where distribution must be begun before the end of next year. They amount in number to 140, with a total length of 170 kilometres, of which about 20 kilometres are at present provided with mains. Of the seven companies who demand concessions, only four, viz., the Secteur de la Place Clichy, the Société Marcel Deprez, the Edison Company, and the Popp Company, have complied with the conditions imposed on them and deposited the caution money. These concessions apply exclusively to the right bank of the river. The report states, however, that the Committee has in its hands two demands for districts on the left bank, which, on account of the short time they have been in its possession, cannot be presented to the Conseil and discussed before the October Session, when the demand of the Berthier Company, to be authorised to lay mains at Passy, Auteuil, and in the Champs-Elysées, will also be considered. After this the Conseil authorised the municipal administration to contract for the buying of two 90 kilo-watt Ferranti alternators and a corresponding number of transformers, but only on the condition that the whole of this material should be manufactured in France. As a matter of fact, the dynamos have already been manufactured at the Cail Works, Grenelle. This plant is intended for the municipal station at present under construction at the Halles Centrales, and which is to be ready to start on the 1st November next. As you are aware, a clause of the Cahier des Charges states that the whole of the plant, electrical or mechanical, wiring, lamps, fittings, &c, employed in or by the central stations, is to be manufactured in France and sold by French firms. Some members of the Conseil having been told that one of the Concessionnaires, which is said to be the Popp Company, had made some contracts for foreign material, steam-engines and dynamos, a Special Commission has been appointed to inquire fully into the facts, and report at the next meeting, when authorisations will be withdrawn from any companies using foreign material or having more than one-tenth of their workmen of foreign origin.

The newly-reconstructed Saint Lazare Station has been provided with a fine installation of the electric light, erected by the Société d'Appareillage et d'Éclairage. The plant comprises three Belleville boilers, capable of furnishing 2,000 kilogrammes of steam per hour; three 140 horse-power Lecouteux and Garnier engines, running at 180 revolutions a minute; each of these engines driving two 450-ampere 100-volt Gramme dynamos connected in series. Two of these groups suffice to do the lighting, the third being held in reserve. The leads are taken from the generating station to the distributing board at the railway station, 750 metres away, the cables being 200 millimetres in section, and in some parts lead-covered. The lights at present running consist of one hundred 10 and 16 candle-power incandescents, one hundred and fifty-three 400 candle-power and eighteen 250 candle-power arcs, but the plant is capable of supplying about 50 per cent. more lamps if required to do so. The arc lamps are all of the Cance type, and are run on separate circuits from the distributing board. The contract prices are five centimes per hour per incandescent lamp, and 30 and 40 centimes per hour for the 250 and 400 candle-power arcs respectively. The agreement between the Société d'Appareillage et d'Éclairage and the Railway Company lasts for ten years, and at the end of this period the Railway Company enters into possession of the entire installation without further payments.

The lighting of the Exhibition has very much improved, and can now be said to be a good, as well as an extensive, example of electric lighting. The jury of Class 62 have finished their labours, and the list of awards will be published at the beginning of next month. Mr. Edison arrived here on Monday from New York, and will probably stay in Paris till the opening of the Congrès International des Électriciens on the 24th inst.

BOOKS, &c., RECEIVED.

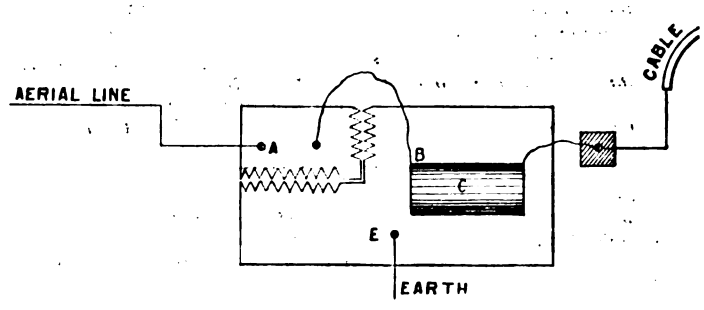
"Glasgow District Telephone Directory, 1889-90." The National Telephone Company.

Illustrated Catalogue, with Practical Instructions as to the Fitting of Electrical Apparatus. (Gent and Co., Faraday Works, Leicester.)

AN IMPROVED LIGHTNING PROTECTOR.

BY A. R. BENNETT.

Experience shows that fusion of coils of fine wire by lightning almost invariably occurs at the commencement of the winding, the high self-induction of the coil forcing a leap at that point, and when a convenient earth is at hand, as in the case of telephonic translators, the primaries of which are earthed, penetration beyond the first layer appears to be altogether unknown, the lightning preferring to jump down the inside of the cheek of the bobbin to the earthed primary. The fact suggests the possibility of constructing that long-sought desideratum, a lightning protector that will *always* protect, by combining a coil of fine wire with a serrated or plain plate discharger, as indicated in the figure, where C is such a coil let into



a rectangular slot in the metal earth-plate E. A is another plate, to which is attached the aerial line, and from which a fine wire communicates with one end of C, the other being to the cable or instrument to be protected. C might with great advantage be wound on a metal core and be enclosed in a metal tube or box, all forming part of or being in contact with the earth-plate E. Such an arrangement, which, so far as I am aware, is novel, would render the passage from coil to earth still easier than in the case of the translator, and would, I believe, be the nearest approach to a perfect protector yet devised, for, according to my experience, currents strong enough to do damage would never pass the point B, at which the winding of fine wire begins. The lightning would be bound to jump at B, and that point being entirely and closely surrounded by the earth-plate its further course would be determined harmlessly. The only disadvantage attending the arrangement would be the probable interruption of service by fusion at B; but as it is, I believe, the practice to earth cables on the approach of a storm—and it would be quite possible to have reserve coils ready to slip into place at hand—the inconvenience might be less serious than at present. The speed of signalling or efficiency of speaking would not be appreciably affected by the use of such protectors, as a few layers of closely-wound No. 40 wire would suffice, and the core, although preferably of metal, need not be of iron. Protection by the insertion of a fine wire in the circuit has long been known, of course, but the intimate association of the fine wire with an earth-plate I do not remember to have seen proposed.

LEGAL INTELLIGENCE.

Butler v. The Kensington and Knightsbridge Electric Lighting Company (Limited).

This was a motion by the owner of the house No. 148, Brompton-road, to restrain the defendant company, until the trial or further order, from using their steam-engines and dynamos and allowing noxious fumes to be emitted from their works, to the annoyance of himself and his family.

Mr. Renshaw, Q.C., and Mr. Maidlow appeared for the plaintiff.

The ATTORNEY-GENERAL (Sir R. Webster, Q.C.), with whom were Mr. Marten, Q.C., and Mr. Wallace, said the case was eminently one in which someone should go down and view the premises, and suggested that the case should go to the Official Referee.

After some discussion

Mr. JUSTICE KAY directed the case to go either to the Official Referee or to some special referee, being a barrister, to be agreed upon between the parties, or, failing agreement, to be nominated by the Chief Clerk, with power for the referee to grant an injunction and enter up judgment.

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And the issue for 1890, which will be still further enlarged and improved, is in preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded to the Publishing Office, 1, Salisbury-court, Fleet-street, London, E.C.

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LOCAL AUTHORITIES AND ELECTRIC LIGHTING COMPANIES.

In the present issue will be found a list of the Local Authorities throughout the United Kingdom who have received notice from Electricity Supply Companies (either general or local) of their intention to apply for a Provisional Order for that locality during the ensuing Parliamentary Session, together with the names of the companies concerned. We publish also a supplementary list showing the number of such applications made by each company. Our readers are aware that the period allowed by the Act for serving these notices expires each year on July 1st, so that the time has now come when at least the outside possibilities of electric lighting during the next twelve months can be fairly estimated. We have been at great pains to make this information as complete and trustworthy as possible, and to this end we have placed ourselves in communication not only with the companies concerned, but in many cases with the Local Authorities as well. We have to acknowledge the well-nigh uniform readiness and courtesy with which our applications have been met. At the

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same time there remain a few instances in which, for one reason or another, we have been unable to obtain definite information. These are, however, scarcely sufficiently numerous to affect the general result. It will be seen that the total number of notices amounts to 479, of which as many as 115 have reference to the Metropolitan Area alone. Before proceeding to comment upon the significance (if any) which these figures may be presumed to possess, it will be as well briefly to analyse the list a little further, in order to see what the more important companies are doing, and upon what line of policy they appear to be moving.

Taking the Metropolis first, we find that the 41 notices of the London Electric Supply Corporation cover almost the whole of London within the four-mile circle from Charing-cross, whilst in some directions they extend to considerable distances beyond that limit. The Corporation proposes not merely to ask for those districts which were not scheduled in its earlier applications; but, refusing to recognise any finality in the recent Board of Trade report, it attacks those parishes which are already in the occupation of others, and from some of which it was lately excluded. The Metropolitan Electric Supply Company has adopted an altogether different policy. Its applications are only six in number, and in each case either the territory is altogether unoccupied, or else, as in the City and in Paddington, the company has already some kind of foothold in the district. That it will get its City Order is practically certain, and it is easy to see that it means business in the other five cases also. The House-to-House Electric Lighting Company having recently given birth to a numerous offspring (11 at one brood), is now confining its own operations to the immediate neighbourhood of the Metropolis. With few exceptions, its 20 applications relate to districts verging on or towards the outskirts of the metropolis, and it is only at Paddington, Lambeth, St. Pancras, Islington, Hackney, and Camberwell that it comes into direct competition with any of its more important rivals. In some half-dozen cases it seems to have secured uncontested territory. Proceeding further, we find that in 12 instances notices have been served by solicitors in the name of "A Company to be formed;" whether this is sufficient to comply with the requirements of the law we do not pretend to know. However, the "Company to be formed" seems anxious to illuminate the purlieus of Whitechapel, Bethnal Green, and Shoreditch, in which enterprise we sincerely wish them every success. Its notices, also, extend over an extensive and desirable area in the West, including Kensington, Paddington, Fulham, and Hammersmith. We have not space for any further analysis of the Metropolitan notices, but a careful perusal of our list will reveal some additional features of interest.

Turning to the Provinces, we are at once struck by the extensive show made by the various offshoots of the House-to-House Company. These companies are responsible between them for no less than 204 notices, and if we add the 20 Metropolitan notices of the parent company this amounts to nearly one-half of the whole number issued. It will be of some interest to see what percentage of these 204 notices are proceeded with during the year. The next largest undertaking (according to this standard of measurement) is that of the Electric Construction and Maintenance Company, which has issued 36 notices, ranging over the country from Dundee in the north to Falmouth in the south, and including such diverse localities as Edinburgh, Liverpool, Cheltenham, Croydon and Darlington. The South-Western District and Thames Valley Electricity Company has issued 21 notices, of which seven are Metropolitan. The Laing, Wharton and Down Construction Syndicate comes next with 14 notices, of which one is Metropolitan; the Municipal Electric Light and Power Corporation follows with 14, the Electric Trust with 12, and the Devon and Cornwall Electricity Supply Company and the Anglo-American Brush Electric Light Corporation with 11 each. The remaining companies may for the most part be divided into two classes: (1) Local Companies, of which outside London there are 21 in the list (including three existing Gas companies), and which for the most part issue single notices and must be supposed to mean business; (2) Companies with wide-sweeping titles, which (like some others already named) are as yet unknown to fame, but which in this case appear to have the good sense to commence operations upon a modest scale. Such are the Electric Lighting Maintenance Company with one notice, the Counties Electricity Supply Corporation with one, the National Electric Supply Company with four, and the Scottish Electric Supply Company with one.

Space will not permit us this week to attempt to draw any conclusions from the state of affairs which is thus disclosed, but we shall hope to return to the subject at an early date.

ELECTRIC LIGHTING NOTICES FOR 1889-90.

The following is a list of the Local Authorities who have been served with notices by Electric Lighting Companies for the ensuing year. In towns marked with an asterisk (*) the Local Authorities have decided themselves to apply for an Order or License, or are considering the advisability of so doing.

METROPOLITAN AREA.

Place.	No. of Applications.	Names of Applicants.
Acton	1	House-to-House Electric Light Supply Company.
Barnes	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Battersea	1	Electric Construction and Maintenance Company.
Bermondsey	1	London Electric Supply Corporation.
Bethnal Green	2	London Electric Supply Corporation. A Company to be formed.
Camberwell	3	Electric Construction and Maintenance Company. House-to-House Electric Light Supply Company. London Electric Supply Corporation.
Chelsea	2	Chelsea Electricity Supply Company. London Electric Supply Corporation.
Chiswick	1	House-to-House Electric Light Supply Company.
City of London.	4	Anglo-American Brush Electric Light Corporation. Laing, Wharton and Down Construction Syndicate London Electric Supply Corporation. Metropolitan Electric Supply Company.
Clerkenwell	2	London Electric Supply Corporation. A Company to be formed.
Ealing	1	House-to-House Electric Light Supply Company.
Edmonton	1	South of England House-to-House Electricity Co.
Finchley	1	House-to-House Electric Light Supply Company.
Fulham	3	House-to-House Electric Light Supply Company. London Electric Supply Corporation. A Company to be formed.
Greenwich	1	London Electric Supply Corporation.
Hackney	3	House-to-House Electric Light Supply Company. London Electric Supply Corporation. A Company to be formed.
Hammersmith	5	Anglo-American Brush Electric Light Corporation. House-to-House Electric Light Supply Company. London Electric Supply Corporation. Metropolitan Electric Supply Company. A Company to be formed.
Hampstead	3	House-to-House Electric Light Supply Company. London Electric Supply Corporation. A Company to be formed.
Hanwell	1	Electricity Supply Corporation.
Hendon	1	House-to-House Electric Light Supply Company.
Holborn	2	Gwynne-Pilsen Electric Company (License). London Electric Supply Corporation.

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Town, &c.	No. of Applications.	Names of Applicants.
Hornsey	1	House-to-House Electric Light Supply Company.
Islington.....	3	House-to-House Electric Light Supply Company. London Electric Supply Corporation. A Company to be formed.
Kensington	3	Chelsea Electricity Supply Company. London Electric Supply Corporation. A Company to be formed.
Kew.....	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Lambeth.....	4	Electric Construction and Maintenance Company. House-to-House Electric Light Supply Company. London Electric Supply Corporation. Metropolitan Electric Supply Company.
Lewisham	3	Electric Construction and Maintenance Company. London Electric Supply Corporation. South of England House-to-House Electricity Co.
Limehouse	2	London Electric Supply Corporation. Metropolitan Electric Supply Company.
Mile End.....	1	London Electric Supply Corporation.
Mortlake...	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Newington	1	London Electric Supply Corporation.
Paddington ...	6	Electricity Supply Corporation. House-to-House Electric Light Supply Company. London Electric Supply Corporation. Metropolitan Electric Supply Company. Westminster Electric Supply Corporation. A Company to be formed.
Penge	1	Electric Construction and Maintenance Company.
Poplar.....	2	London Electric Supply Corporation. Metropolitan Electric Supply Company.
Putney.....	3	House-to-House Electric Light Supply Company. London Electric Supply Corporation. South-Western District and Thames Valley Electricity Supply Company.
Roehampton ...	1	South-Western District and Thames Valley Electricity Supply Company.
Rotherhithe ...	1	London Electric Supply Corporation.
St. George-in-the-East	1	London Electric Supply Corporation.
St. George the Martyr, Southwark	1	London Electric Supply Corporation.
St. George's, Hanover-sq.	3	Chelsea Electricity Supply Company. London Electric Supply Corporation. Westminster Electric Supply Corporation.
St. Giles's	2	Electricity Supply Corporation. London Electric Supply Corporation
St. James's.....	2	London Electric Supply Corporation. St. James's and Pall Mall Electric Light Company.
St. Leonard's, Shoreditch	2	London Electric Supply Corporation. A Company to be formed.
St. Luke, Middlesex	1	London Electric Supply Corporation.
St. Margaret and St. John's	3	City of Westminster Electrical Syndicate (License). London Electric Supply Corporation. Westminster Electric Supply Corporation.
St. Martin's-in-the-Fields	2	Electricity Supply Corporation. London Electric Supply Corporation.
St. Marylebone	3	London Electric Supply Corporation. Westminster Electric Supply Corporation. A Company to be formed.
St. Olave.....	1	London Electric Supply Corporation.
St. Pancras.....	2	House-to-House Electric Light Supply Company. London Electric Supply Corporation.
St. Saviour and Christchurch	1	London Electric Supply Corporation.
Strand.....	2	Electricity Supply Corporation. London Electric Supply Corporation.
Turnham Green	1	South of England House-to-House Electricity Co.
Wandsworth ...	3	House-to-House Electric Light Supply Company. London Electric Supply Corporation. South-Western District and Thames Valley Electricity Supply Company.
West Ham	2	House-to-House Electric Light Supply Company. London Electric Supply Corporation.
Whitechapel ...	2	London Electric Supply Corporation. A Company to be formed
Willesden	1	House-to-House Electric Light Supply Company.
Wimbledon	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Woolwich	1	London Electric Supply Corporation.

PROVINCES.

Town, &c.	No. of Applications.	Names of Applicants.
Aberdare.....	1	Western House-to-House Electricity Company.
Aberdeen	2	Messrs. Norman and Son. Scottish House-to-House Electricity Company.
Aberdeenshire..	1	Messrs. Norman and Son.
Aberystwith ...	1	Midland House-to-House Electricity Company.
Accrington	1	Lancashire and Cheshire House-to-House Electricity Company.
Aldershot	1	South of England House-to-House Electricity Co.
Arbroath	1	Scottish House-to-House Electricity Company.
Ashton-under-Lyne	1	Lancashire and Cheshire House-to-House Electricity Company.
Atherton.....	1	Lancashire and Cheshire House-to-House Electricity Company.
*Ayr	2	Messrs. Norman and Son. Scottish House-to-House Electricity Company.
Ayrshire	1	Messrs. Norman and Son.
Bacup	2	Lancashire and Cheshire House-to-House Electricity Company. Municipal Electric Light and Power Corporation.
Balsall Heath ...	1	Midland House-to-House Electricity Company.
Barnet..... ...	1	Joel and Co.
Barnsley	3	Municipal Electric Light and Power Corporation. National Electric Supply Company. Yorkshire House-to-House Electricity Company.
Barrow-in-Furness	1	Lancashire and Cheshire House-to-House Electricity Company.
Bath..... ...	2	Local Company (shares not taken up). Western House-to-House Electricity Company.
Batley	1	Yorkshire House-to-House Electricity Company.
Beckenham.....	1	Electric Construction and Maintenance Company.
Bedford	1	Midland House-to-House Electricity Company.
Belfast.....	1	Irish House-to-House Electricity Company.
*Birkenhead ...	2	Electric Construction and Maintenance Company. Liverpool House-to-House Electricity Company.
Birmingham	3	Birmingham House-to-House Electricity Company. Messrs. Chamberlain and Hookham. Laing, Wharton and Down Construction Syndicate.
*Blackburn	4	Electric Construction and Maintenance Company. Lancashire and Cheshire House-to-House Electricity Company. Municipal Electric Light and Power Corporation. National Electric Supply Company.
Blackpool	1	Lancashire and Cheshire House-to-House Electricity Company.
Bognor	1	Electric Trust.
Bolton.....	1	Lancashire and Cheshire House-to-House Electricity Company.
Bootle.....	1	Lancashire and Cheshire House-to-House Electricity Company.
Boston.....	1	Midland House-to-House Electricity Company.
Bournemouth...	3	Anglo-American Brush Electric Light Corporation. Electric Construction and Maintenance Company. South of England House-to-House Electricity Co.
Brighton.....	1	Brighton and Hove Electric Light Company.
Bristol.....	2	Laing, Wharton and Down Construction Syndicate. Western House-to-House Electricity Company.
Bromley	1	South of England House-to-House Electricity Co.
Bromsgrove ...	1	Midland House-to-House Electricity Company.
Burnley	1	Lancashire and Cheshire House-to-House Electricity Company.
Burslem	2	Midland House-to-House Electricity Company. Municipal Electric Light and Power Corporation.
Burton-on-Trent	3	Messrs. Crompton and Co. Midland House-to-House Electricity Company. South Staffordshire Electric Lighting Company.
Bury	1	Lancashire and Cheshire House-to-House Electricity Company.
Buteshire	1	Messrs. Norman and Son

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Town, &c.	No. of Applications.	Names of Applicants.
Buxton	2	Electric Construction and Maintenance Company. Municipal Electric Light and Power Company.
*Cambridge ...	4	Cambridge University and Town Electric Lighting Company. Electric Construction and Maintenance Company. Electric Trust. Midland House-to-House Electricity Company.
Canterbury ...	2	Electric Construction and Maintenance Company. South of England House-to-House Electricity Company.
Cardiff	5	Anglo-American Brush Electric Light Corporation. Messrs. Crompton and Co. Electric Construction and Maintenance Company. Electric Trust. Western House-to-House Electricity Company.
Carlisle	1	Northern House-to-House Electricity Company.
Chatham	4	Chatham, Rochester and District Electric Light Co. Electric Construction and Maintenance Company. Municipal Electric Light and Power Corporation. South of England House-to-House Electricity Co.
Cheltenham ...	5	Anglo-American Brush Electric Light Corporation. Electric Construction and Maintenance Company, Laing, Wharton and Down Construction Syndicate. Western House-to-House Electricity Company. A Company to be formed.
Chertsey	1	South-Western District and Thames Valley Electricity Supply Company.
Chester	2	Lancashire and Cheshire House-to-House Electricity Company. Laing, Wharton and Down Construction Syndicate.
Chesterfield ...	1	Messrs. Crompton and Co.
Clee-with-Welsby	1	Midland House-to-House Electricity Company.
Colchester	1	South of England House-to-House Electricity Co.
Coombe	1	South-Western District and Thames Valley Electricity Supply Company.
Cork	1	Irish House-to-House Electricity Company.
Coventry	1	Midland House-to-House Electricity Company.
Crediton	1	Devon and Cornwall Electricity Supply Company.
Crewe	1	Liverpool House-to-House Electricity Company.
Croydon	3	Croydon Electric Supply Company. Electric Construction and Maintenance Company. South of England House-to-House Electricity Co.
Crumpsall	1	Manchester House-to-House Electricity Company.
*Darlington ...	3	Electric Construction and Maintenance Company. Municipal Electric Light and Power Corporation. Northern House-to-House Electricity Company.
Darwen	2	Lancashire and Cheshire House-to-House Electricity Company. Municipal Electric Light and Power Corporation.
*Derby	2	Laing, Wharton and Down Construction Syndicate. Midland House-to-House Electricity Company.
Devonport	1	Devon and Cornwall Electricity Supply Company.
Dewsbury	1	Yorkshire House-to-House Electricity Company.
Doncaster	1	Yorkshire House-to-House Electricity Company.
Dorking	1	South of England House-to-House Electricity Co.
Dover	5	Messrs. Crompton and Co. Electric Construction and Maintenance Company. Laing, Wharton and Down Construction Syndicate. Municipal Electric Light and Power Corporation. South of England House-to-House Electricity Co.
Dublin	2	Messrs. Colton and Co. Irish House-to-House Electricity Company.
Dudley	2	Midland House-to-House Electricity Company. Wolverhampton Electric Light and Power Company.
Dundee	3	Anglo-American Brush Electric Light Corporation. Electric Construction and Maintenance Company. Scottish House-to-House Electricity Company.
Durham	1	Northern House-to-House Electricity Company.
Edinburgh	6	Anglo-American Brush Electric Light Corporation. Messrs. Crompton and Co. Electric Construction and Maintenance Company. Electricity Supply Corporation. Scottish Electric Supply Company. Scottish House-to-House Electricity Company.
Epping	1	Municipal Electric Light and Power Corporation.
Exeter	2	Devon and Cornwall Electricity Supply Company. Electric Construction and Maintenance Company.
Falmouth	3	Devon and Cornwall Electricity Supply Company. Electric Construction and Maintenance Company. Falmouth Gas, Coal and Coke Company.
Farnworth	1	Lancashire and Cheshire House-to-House Electricity Company.
Fenton	1	Midland House-to-House Electricity Company.
*Fleetwood.....	1	The Local Authority.
Folkestone	3	Messrs. Crompton and Co. (License). Electric Trust. South of England House-to-House Electricity Co.
Gillingham	2	Chatham, Rochester and District Electric Light Co. Municipal Electric Light and Power Corporation.
Glasgow	7	Anglo-American Brush Electric Light Corporation. Electric Construction and Maintenance Company. Kelvinside Electricity Company. Messrs. Muir, Mavor and Coulson. Messrs. Norman and Son. Partick, Hillhead and Maryhill Gas Company. Scottish House-to-House Electricity Company.
Glossop	1	Midland House-to-House Electricity Company.
Gloucester	4	Electric Construction and Maintenance Company. Laing, Wharton and Down Construction Syndicate. Municipal Electric Light and Power Corporation. Western House-to-House Electricity Company.
Grantham	1	Midland House-to-House Electricity Company.
Gravesend	1	South of England House-to-House Electricity Co.
Great Grimsby.	1	Midland House-to-House Electricity Company.
Great Horton...	1	Yorkshire House-to-House Electricity Company.
Greenock	1	Scottish House-to-House Electricity Company.
Guildford	1	South of England House-to-House Electricity Co.
Halifax	2	Electric Construction and Maintenance Company. Yorkshire House-to-House Electricity Company.
Ham	1	South-Western District and Thames Valley Electricity Supply Company.
*Hamilton	1	Scottish House-to-House Electricity Company.
Hampton.....	1	South of England House-to-House Electricity Co.
Hampton Wick.	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Handsworth ...	1	Birmingham House-to-House Electricity Company.
Hanley	1	Midland House-to-House Electricity Company.
Harborne	1	Birmingham House-to-House Electricity Company.
Harrogate	1	Laing, Wharton and Down Construction Syndicate
Hastings	2	Hastings and St. Leonard's Electric Light Company. South of England House-to-House Electricity Co.
Hawick	1	Scottish House-to-House Electricity Company.
Hereford.....	1	Western House-to-House Electricity Company.
Heston and Isleworth	1	House-to-House Electric Light Supply Company.
Heywood	1	Lancashire and Cheshire House-to-House Electricity Company.
Hinckley.....	1	Midland House-to-House Electricity Company.
Horfield	2	Electric Lighting Maintenance Company. Western House-to-House Electricity Company.
Horwich	1	Lancashire and Cheshire House-to-House Electricity Company.
*Hove	3	Brighton and Hove Electric Lighting Company. Electric Construction and Maintenance Company. A Company to be formed.
Huddersfield ...	1	Yorkshire House-to-House Electricity Company.
Hull.....	5	Messrs. Crompton and Co. Electric Construction and Maintenance Company. Kingston-upon-Hull Electric Supply Company. National Electric Supply Company. Yorkshire House-to-House Electricity Company.
Hunslet	1	Yorkshire House-to-House Electricity Company.
Hyde	1	Midland House-to-House Electricity Company.
Ilkeston	1	Midland House-to-House Electricity Company.
Ipswich	1	Midland House-to-House Electricity Company.
Jarrow	1	Northern House-to-House Electricity Company.
*Johnstone ...	1	Scottish House-to-House Electricity Company.
Keighley	2	Yorkshire House-to House Electricity Company.
Kidderminster..	1	Midland House-to-House Electricity Company.
Kilmarnock ...	1	Scottish House-to-House Electricity Company.
Kingston(Surrey)	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Corporation.
Kirkcaldy	1	Scottish House-to-House Electricity Company.

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Town, &c.	No. of Applications.	Names of Applicants.
Lanark	1	Messrs. Norman and Son.
Lancaster	1	Lancashire and Cheshire House-to-House Electricity Company.
Leamington ...	1	Midland House-to-House Electricity Company.
*Leeds.....	1	Yorkshire House-to-House Electricity Company.
Leicester.....	2	Electric Trust. Midland House-to-House Electricity Company.
Leigh	1	Midland House-to-House Electricity Company.
*Leith.....	4	Anglo-American Brush Electric Light Corporation. Electric Construction and Maintenance Company. Scottish Electric Supply Company. Scottish House-to-House Electricity Company.
Leyton.....	1	South of England House-to-House Electricity Co.
Limerick.....	1	Irish House-to-House Electricity Company.
Lincoln	1	Midland House-to-House Electricity Company.
Liskeard	1	Devon and Cornwall Electricity Supply Company.
Liverpool	3	Electric Construction and Maintenance Company. Liverpool Electric Supply Company. Liverpool House-to-House Electricity Company.
Llanelly	1	Western House-to-House Electricity Company.
Londonderry ...	1	Irish House-to-House Electricity Company.
Long Ditton ...	1	South-Western District and Thames Valley Electricity Supply Company.
Long Eaton.....	1	Midland House-to-House Electricity Company.
Longton	1	Midland House-to-House Electricity Company.
Loughborough..	1	Midland House-to-House Electricity Company.
Lowestoft	2	Lowestoft Electric Light Supply Company. Midland House-to-House Electricity Company.
Luton	1	Midland House-to-House Electricity Company.
Lyndhurst	1	Electric Trust.
Macclesfield.....	1	Lancashire and Cheshire House-to-House Electricity Company.
Maidstone	3	Electric Construction and Maintenance Company. Municipal Electric Light and Power Corporation. South of England House-to-House Electricity Co.
Maindee	1	Lancashire and Cheshire House-to-House Electricity Company.
Malvern	1	Midland House-to-House Electricity Company.
*Manchester ...	2	Laing, Wharton and Down Construction Syndicate. Manchester House-to-House Electricity Company.
Margate	1	South of England House-to-House Electricity Co.
Melton Mowbray	1	Midland House-to-House Electricity Company.
Merthyr Tydfil..	1	Western House-to-House Electricity Company.
Middlesborough	1	Yorkshire House-to-House Electricity Company.
Milnrow	1	Lancashire and Cheshire House-to-House Electricity Company.
Moss Side	1	Manchester House-to-House Electricity Company.
Newcastle-under-Lyme	1	Midland House-to-House Electricity Company.
Newcastle-upon-Tyne	2	Newcastle-upon-Tyne Electric Supply Company. Newcastle and District Electric Lighting Company.
Newport, I.W..	1	South of England House-to-House Electricity Co.
Newport, Mon..	2	Electric Trust. Western House-to-House Electricity Company.
Newton Heath .	1	Lancashire and Cheshire House-to-House Electricity Company.
Norbiton.....	1	South-Western District and Thames Valley Electricity Supply Company.
Northampton...	2	Midland House-to-House Electricity Company. Northampton Electric Light and Power Company.
Nottingham ...	1	Midland House-to-House Electricity Company.
Nuneaton	1	Midland House-to-House Electricity Company.
Okehampton ...	1	Devon and Cornwall Electricity Supply Company.
Oldbury	1	Lancashire and Cheshire House-to-House Electricity Company.
Oldham	1	Lancashire and Cheshire House-to-House Electricity Company.
Oxford.....	1	Midland House-to-House Electricity Company.
Paisley.....	1	Scottish House-to-House Electricity Company.
Pendleton	1	Lancashire and Cheshire House-to-House Electricity Company.
Penzance.....	1	Devon and Cornwall Electricity Supply Company.
Perth	1	Scottish House-to-House Electricity Company.
*Peterborough..	1	Midland House-to-House Electricity Company.
Petersham	1	South-Western District and Thames Valley Electricity Supply Company.
Plymouth	2	Devon and Cornwall Electricity Supply Company. Electric Trust.
Poole	2	Anglo-American Brush Electric Light Corporation. Electric Construction and Maintenance Company.
Portsmouth ...	2	Laing, Wharton and Down Construction Syndicate. Portsmouth and South Hants Electricity Supply Co.
Preston	1	Lancashire and Cheshire House-to-House Electricity Company.
Radford	1	Midland House-to-House Electricity Company.
Ramsgate.....	1	South of England House-to-House Electricity Co.
Rawtenstall	1	Lancashire and Cheshire House-to-House Electricity Company.
Reading	3	Electric Construction and Maintenance Company. South of England House-to-House Electricity Co. A Company to be formed.
Reigate	1	South of England House-to-House Electricity Co.
Richmond (Surrey).....	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Rochdale.....	3	Electric Construction and Maintenance Company. Lancashire and Cheshire House-to-House Electricity Company. Municipal Electric Light and Power Corporation.
Rochester	2	Chatham and Rochester Electric Lighting Company. South of England House-to-House Electricity Co.
Rotherham.....	2	Yorkshire House-to-House Electricity Company.
Rothsay	1	Messrs. Norman and Son.
Rugby.....	1	Midland House-to-House Electricity Company.
Ryde	1	South of England House-to-House Electricity Co.
Saddleworth ...	1	Yorkshire House-to-House Electricity Company.
*St. Helens.....	1	Lancashire and Cheshire House-to-House Electricity Company.
*Salford	1	Manchester House-to-House Electricity Company.
Salisbury	1	Western House-to-House Electricity Company.
Scarborough ...	1	Yorkshire House-to-House Electricity Company.
Sevenoaks	1	Electric Trust.
Shardlow	1	Midland House-to-House Electricity Company.
Sheffield	1	Electric Construction and Maintenance Company.
Shrewsbury ...	2	Messrs. Crompton and Co. Midland House-to-House Electricity Company.
Smethwick	1	Midland House-to-House Electricity Company.
Southampton...	3	Electric Construction and Maintainance Company. South of England House-to-House Electricity Co. Southampton Electric Light and Power Company.
Southport	1	Lancashire and Cheshire House-to-House Electricity Company.
South Shields...	1	Northern House-to-House Electricity Company.
Stafford	1	Midland House-to-House Electricity Company.
Staleybridge ...	1	Lancashire and Cheshire House-to-House Electricity Company.
Stockport	1	Lancashire and Cheshire House-to-House Electricity Company.
Stockton-on-Tees	2	Municipal Electric Light and Power Corporation. Northern House-to-House Electricity Company.
Stoke-on-Trent.	1	Midland House-to-House Electricity Company.
Stonehouse.....	1	Devon and Cornwall Electricity Supply Company.
Stourbridge ...	2	Wolverhampton Electric Light and Power Company.
Stroud..... ...	1	Western House-to-House Electricity Company.
Sunderland.....	1	Sunderland and District Electricity Supply Company.
Surbiton	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Swansea	1	Electric Trust.
Swindon	1	Western House-to-House Electricity Company.
Teddington.....	2	South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Thames Ditton.	1	South-Western District and Thames Valley Electricity Supply Company.
Tipton.....	1	Midland House-to-House Electricity Company.
Todmorden.....	1	Midland House-to-House Electricity Company.
Torquay	1	Devon and Cornwall Electricity Supply Company.

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Town, &c.	No. of Applications.	Names of Applicants.
Truro	1	Truro Gas Company.
Tunbridge Wells	1	South of England House-to-House Electricity Co.
Tunstall	1	Electric Trust.
Twickenham ...	3	Counties Electricity Supply Corporation. South of England House-to-House Electricity Co. South-Western District and Thames Valley Electricity Supply Company.
Tynemouth.....	1	Northern House-to-House Electricity Company.
Wakefield	3	Electric Construction and Maintenance Company. National Electric Supply Company. Yorkshire House-to-House Electricity Company.
*Walsall	3	Midland House-to-House Electricity Company. South Staffordshire Electric Lighting Company. Wolverhampton Electric Light and Power Company.
Walthamstow ...	1	South of England House-to-House Electricity Co.
Walton-on-Thames	1	South-Western District and Thames Valley Electricity Supply Company.
Warrington ...	1	Lancashire and Cheshire House-to-House Electricity Company.
Waterford	1	Irish House-to-House Electricity Company.
Wednesbury ...	1	Wolverhampton Electric Light and Power Company.
West Bromwich	2	Midland House-to-House Electricity Company. Wolverhampton Electric Light and Power Company.
West Hartlepool	1	Northern House-to-House Electricity Company.
Weston-super-Mare	1	Laing, Wharton and Down Construction Syndicate.
Weybridge	2	South-Western District and Thames Valley Electricity Supply Company. Woking Electric Supply Company.
Weymouth	1	Devon and Cornwall Electricity Supply Company.
Whitby	1	Yorkshire House-to-House Electricity Company.
Whitehaven ...	1	Northern House-to-House Electricity Company.
Widnes	1	Lancashire and Cheshire House-to-House Electricity Company.
Wigan	1	Lancashire and Cheshire House-to-House Electricity Company.
Winchester.....	2	Laing, Wharton and Down Construction Syndicate. South of England House-to-House Electricity Co.
Windsor	2	Electric Trust. South of England House-to-House Electricity Co.
Withington.....	2	Anglo-American Brush Electric Light Corporation. Manchester House-to-House Electricity Company.
Woking	1	Woking Electric Supply Company.
Wolverhampton	2	Midland House-to-House Electricity Company. Wolverhampton Electric Light and Power Company.
Worcester	1	Midland House-to-House Electricity Company.
Wortley	1	Yorkshire House-to-House Electricity Company.
Wrexham	2	Midland House-to-House Electricity Company. Wrexham and District Electric Supply Company.
Yarmouth	1	Midland House-to-House Electricity Company.
York.....	2	Yorkshire House-to-House Electricity Company. Laing, Wharton and Down Construction Syndicate.

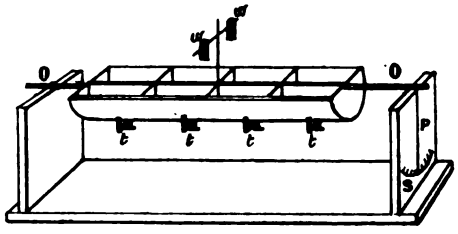
The following list shows the number of notices which have been served by each Company individually :—

Name of Company.	No. of Notices Given.
Anglo-American Brush Electric Light Corporation	11
Birmingham House-to-House Electricity Company	3
Brighton and Hove Electric Light Company	2
Cambridge University and Town Electric Light Company	1
Chamberlain and Hookham, Messrs.	1
Chatham, Rochester and District Electric Light Company	3
Chelsea Electricity Supply Company	3
City of Westminster Electrical Syndicate	1
Colton and Co., Messrs.	1
Counties Electricity Supply Corporation	1
Crompton and Co., Messrs.	8
Croydon Electric Supply Company	1
Devon and Cornwall Electricity Supply Company	11
Electric Construction and Maintenance Company	31
Electric Lighting Maintenance Company	1
Electric Trust	12
Electricity Supply Company	5
Falmouth Gas, Coal and Coke Company	1
Gwynne-Pilsen Electric Company	1
Hastings and St. Leonard's Electric Light Company	1
House-to-House Electric Light Supply Company	20
Irish House-to-House Electricity Company	6
Joel and Co., Messrs.	1
Kelvinside Electricity Company	1
Kingston-upon-Hull Electric Supply Company	1
Laing, Wharton and Down Construction Syndicate	14
Lancashire and Cheshire House-to-House Electricity Company	34
Liverpool Electric Supply Company	1
Liverpool House-to-House Electricity Company	3
London Electric Supply Corporation	41
Lowestoft Electric Light Supply Company	1
Manchester House-to-House Electricity Company	5
Metropolitan Electric Supply Company	6
Midland House-to-House Electricity Company	54
Muir, Mavor and Coulson, Messrs.	1
Municipal Electric Light and Power Corporation	14
National Electric Supply Company	4
Newcastle and District Electric Lighting Company	1
Newcastle-upon-Tyne Electric Supply Company	1
Norman and Son, Messrs.	8
Northampton Electric Light and Power Company	1
Northern House-to-House Electricity Company	9
Partick, Hillhead and Maryhill Gas Company	1
Portsmouth and South Hants Electricity Supply Company	1
St. James's and Pall Mall Electric Light Company	1
Scottish Electric Supply Company	1
Scottish House-to-House Electricity Company	15
South of England House-to-House Electricity Company	42
South Staffordshire Electric Lighting Company	2
South-Western District and Thames Valley Electricity Supply Co.	21
Southampton Electric Light and Power Company	1
Sunderland and District Electricity Supply Company	1
Truro Gas Company	1
Western House-to-House Electricity Supply Company	14
Westminster Electric Supply Corporation	4
Woking Electric Supply Company	2
Wolverhampton Electric Light and Power Company	6
Wrexham and District Electric Supply Company	1
Yorkshire House-to-House Electricity Company	19
	459
Companies to be formed	15
	474

ON A MECHANICAL MODEL, ILLUSTRATING THE RESIDUAL CHARGE IN A DIELECTRIC.*

BY J. H. POYNTING, D.SC., F.R.S.

The model is designed to exhibit a phenomenon analogous to the residual charge which gathers in a condenser after it has been charged and then discharged, when the dielectric is not a perfect insulator. Its mode of action is similar to that which Maxwell supposes to occur in the dielectric. According to his theory the residual charge is due to the breaking down of the state of strain (or, perhaps, more correctly, of the stress) in the dielectric corresponding to the original charge, but in an uneven manner in different parts of the dielectric, so that just before the discharge the stress is greater in some parts than in others. On discharging, it is impossible, from the nature of electric discharge, to remove all the strain by connecting the two plates of the condenser, and the condition of equilibrium which is arrived at consists in an actual reversal of the strain in the parts where the breaking down has been most rapid, the reversed stress in these parts balancing the remnant of the original stress in the other parts. On insulation, the strain breaks down again, and at the greatest rate in the same layers, now reversed. Consequently the reversed stress is no longer able to balance the direct stress, and, on the whole, there is a preponderance of strain in the original direction, or a gathering of charge the same in kind as the original charge.



The model consists of a trough (*see* Figure) of semicircular

* Paper read before the Birmingham Philosophical Society, November, 1888.

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cross section, 24in. long, 6in. diameter, and divided into eight equal compartments by a middle partition along the axis and three cross partitions. It is supported at the two ends, so that it can rotate about its axis O O, a pointer P attached to one end moving in front of a scale S. Four pipes, with taps $t\ t\ t\ t$, connect the opposite compartments when the taps are turned on. The trough is balanced by the weights $w\ w$, so that when empty it is in neutral equilibrium. Turning the taps off, and pouring in water to the same depth in all the compartments, the equilibrium at once becomes stable, and the trough, if displaced, stores up energy. It may be considered as analogous to a "tube of force," connecting charges $\pm q$ on the surfaces of two opposite conductors, the axis of the trough representing the axis of the tube of force, the angle of displacement the charge at either end, or the induction along the tube. A clockwise rotation at the pointer end might signify a positive charge at that end. As long as the taps are off the trough represents a perfect insulator, a displacement through a given angle, and fixture at that angle, corresponding to the communication of a charge and subsequent insulation. The energy remains in the trough undissipated. Discharge, of course, corresponds to release of the trough, and we have oscillations corresponding to the electrical oscillations brought recently into such prominence. It may be noted that a decrease in the quantity of water corresponds to an increase in specific inductive capacity, while a decrease in the weight of the trough corresponds to an increase in magnetic permeability. We might, perhaps, obtain an analogy to the spark discharge by completing the cylinder, of which the trough forms half, and carrying the partitions up through the added half. On turning the trough through anything more than a right angle it would fall over and oscillate about a new position 180deg. from the original one, the discharge of energy occuring now with an increase of strain, not with a return to the unstrained condition. If the taps are turned on, but all to the same extent, the trough corresponds to a "leaky" dielectric in which the conductivity is uniform. Turning the trough through a given angle, and holding it, the water begins to flow back from the higher to the lower compartments, thus dissipating the energy, and if after a short time the trough is released it returns to a position short of the original position, and remains there, the level of the water in the two sides of the middle partition being the same. But if the taps are turned on by different amounts—if, for example, the two end taps are turned off while the two middle ones are turned on, then turning the trough through a given angle and holding it the energy of the two middle pairs of compartments is gradually lessened, and on release the trough moves part way back. But now it is only the mean level which is the same on the two sides. In the two pairs of compartments with no communication there is still a positive difference of level, while in the other two there is now a negative difference. Holding the trough in its new position for a short time, the negative difference is reduced by leakage from one side to the other, and on release the trough returns by another amount towards its original position—and this may be repeated several times, until finally the original position is sensibly regained.

The first model I made, for ease of construction and without sufficient consideration, with rectangular instead of circular cross section; and with this the phenomenon of residual charge is obtained, even though all the taps are turned on equally. For consider what happens if the trough is turned through an angle and held. The water comes to a level after a time, but still its centre of gravity is not in the lowest possible position, and on release the trough returns part way, making a negative difference of level between the two sides. Again holding it, this difference is reduced, and on release there is another return, and so on. This suggests that possibly residual charge may occur not only when the substance is heterogeneous, and also when it is homogeneous, if with electric induction or strain there is both energy of the molecules as a whole and internal energy between the parts of each molecule. If the latter dies away after the bounding conductors are charged, the former may still remain, and on discharge it is possible that it may not all be dissipated, but may partly go to renew the internal energy. If this renewal accompanies a reversal of the direction of electric strain, we shall have the phenomena of residual charge.

It is hardly necessary to point out that the model serves equally as an illustration of a possible explanation of elastic after-action. It is evident that the phenomenon of residual charge will always occur when a body strained is such that the stress dies away unequally in different parts, while at the same time its constitution is such that on release from strain an equal amount of strain is taken from each part.

From this illustration of residual charge we may pass to a possible analogue of conduction in a metal wire. Let us suppose the trough replaced by a hollow cylinder, with its axis horizontal, ends closed, and without partitions. If the cylinder is only partly filled with water, a small couple applied to it will produce continuous rotation, but with a limiting angular velocity, attained when the water is dragged up in one side so far that the moment of its weight about the axis is equal to that of the applied couple. The energy put in by the couple is all ultimately converted into heat in the water. Thus the angular displacement increases indefinitely, though the stress always remains small. Similarly, as I believe, the "electric strain," or "induction," or "displacement" in a wire carrying a current increases indefinitely, as induction is continually coming into it from the outside, although the stress always remains small.

LIGHTNING, LIGHTNING CONDUCTORS, AND LIGHTNING PROTECTORS *

(Continued from page 356.)

In Mr. Symons' objection to laboratory experiments being regarded as at all analogous to lightning, and still more clearly in Captain Cardew's solemn protest in favour of the dignity of a thunderstorm and the absence of dignity from experiments conducted with tinplate, I seem to hear echoes of some fine old crusted objections which were current in the time of Franklin, and which were, perhaps, somewhat more in harmony with that time than with the present. Now that the subject has been mooted, however, I may be permitted to assert my conviction that the intrinsic dignity and solemnity of Nature is as present in a spark one inch, as in a spark one mile long; that, looked at with insight, a drop of ink hanging from a funnel† may be as inspiring an object of contemplation as a cataract; and that to explicitly claim special dignity for the one is implicitly to reject it from the other. True, one's subjective feelings of awe are not aroused in the one case as in the other, but that has to do with the relative size of the human body; and so far as an observer is overwhelmed or liable to have his nerves shattered out of existence by the phenomenon he is witnessing, just so far he is not in a perfectly collected and scientific frame of mind. Moreover, experiment under modifiable circumstances has enormous advantages over mere observation, especially observation which is only occasionally possible. Hence experiments in a laboratory and a thorough understanding of what occurs on a small scale are a very good introduction to the enlightened study of atmospheric electricity, though they are by no means to be regarded as a substitute for that direct study. So let me here emphatically admit and insist, in full agreement with what I suppose was the intention of these speakers, and with the more direct assertion of Colonel Armstrong, that experiments on actual lightning are highly desirable. Such experiments, as a sort of practical outcome of the Mann lectures, are, I hope, in course of establishment, by means of the bright idea of the editor of *The Electrician*, and by the enlightened co-operation of the Eastern Telegraph Company and Sir James Anderson. At foreign stations storms are frequent, and, with suitable appliances, I trust a record of valuable observations may be forthcoming in, say, five or ten years—without, let us hope, the "expenditure of any observers." The large number of photographic records of lightning which are now being obtained all over the country are likewise very valuable aids to progress.

Mr. Symonds is a determined and consistent advocate of large cross-section for conductors, maintaining that they are liable to be fused; and as this is a question of observation and experience of damage, I should be disposed to allow much weight to his opinion. Unfortunately, however, the two instances he adduces in support of his contention are not such as will bear serious examination,‡ since in one it is the links of a chain which are melted, and in the other the conductor is not fused, but merely "burnt by use."

Mr. Symons beautifully illustrates my remark that whenever a building is damaged it is always because the infallible rules of the Lightning Rod Conference had not been followed. The church at Garding was damaged because "they took the conductor down the *North* side of the steeple, not down the *wet* side, as we advised!"

With reference to his depreciatory observations on the Hotel de Ville, Brussels, and the Belgian School of Electricians, I shall leave them to speak for themselves. Mr. Symons will find that the death of M. Melsens has by no means removed from that country every man skilled in lightning conductor appliances.

I do not know who it is that has told Mr. Symons that all the lightning conductors "on the Houses of Parliament, Westminster Abbey, or wherever it may be, are wrong in principle and are dangerous." Certainly I have not. I have never either said or implied that a well-erected lightning conductor is other than a source of safety as far as it goes. I said in my first Mann lecture that the neighbourhood of a factory chimney is "a source of mild danger." And so I believe it is, even when possessing a good conductor. But, most distinctly, without a conductor it would be a

* From the *Journal* of the Institution of Electrical Engineers.

† Sir. W. Thomson's "Popular Lectures and Addresses," page 48.

‡ *See* Appendix III.

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source of danger very much other than "mild." I never contemplated such a case, nor supposed that anyone would endeavour to increase their safety by pulling down lightning conductors.

Colonel Armstrong quotes several cases of damage wherein the earth resistance was found to be from 100 to 200 ohms. With all deference to his experience, I feel very doubtful if this amount of resistance is sufficient to account for the damage. I have admitted all along that the better the "earth" the better for everybody; but I have also pointed out numerous other reasons for failure and damage beside a bad earth.

In his most interesting observation of the cartridges exploded in a sealed metal case, we ought to be sure that the flash did not pierce, or melt, or ignite to redness, the case. Any violence of that sort might explode things in a very commonplace and unelectrical fashion. So also the violent shock due to expansion of air, or what Sir W. Thomson at Bath called the sound-wave, may be expected to have an effect on detonators.

Mr. Adams calls attention to the radiation of energy from conductors. It is most true that radiation goes on from all alternating circuits; and from linear oscillators like those of Hertz, or, what is essentially the same thing, from cloud and earth joined by a lightning conductor, the intensity of radiation is prodigious. It is a most important way of getting rid of energy; it is expended on the other at the rate of many horse-power. See a Paper of mine in the forthcoming July *Philosophical Magazine*. I am not sure, however, that the experiments of Mr. Adams illustrate this radiation very exactly. Nor do I quite understand his last sentence. If the facts be as he states, do they not place iron above copper rather than below it?

Mr. Spagnoletti's statements are most interesting. Mr. W. Groves, of Bolsover-street, tells me he has seen the alphabetical step-by-step machine worked two or three letters forward by atmospheric electricity of some kind on a wire between his place and Sir Charles Wheatstone's.

Mr. Evershed's observations on clouds go to support the conclusion that the well-known "return stroke," and such like observations, prove the conducting nature of clouds—of some clouds at any rate.

He is quite right in pointing out that all oscillatory character is liable to be wiped out of a discharge which has had to travel a great length of thin wire, and that the finding of a quiet tail of current leaking away in some obscure corner of a telegraph instrument is no criterion as to the vigour or character of the main flash whence it arose.

Passing to the criticisms communicated since the meeting, I have no special remark to make on the statements of Major Cardew except to say that several seem to be mere statements of peronals opinion, rather lightly and casually made.

With respect to No. 30, "We all know there are millions of volts," my point is misapprehended. It is familiar that there are millions of volts between cloud and earth; it is not familiar that there may be millions of volts between the top of a well-earthed and stout copper lightning conductor and the earth. When Major Cardew says, as he does towards the end of his remarks, under head "*Fourth*," that a conductor of small impedance is desirable, everyone must agree with him; but when he goes on to say that such a conductor is obtained by following the rules of the Lightning Rod Conference (or any other rules for that matter), it is necessary to disagree with him. The impedance could not be considered in any sense "small," even if a column of pure copper, a foot in diameter, was employed. The impedance of such a column, 100 metres high, to a current of frequency one million per second, is nearly 900 ohms.

Major Cardew twits me with having supposed that an earth resistance can be got as low as one-thousandth of an ohm, but if he chooses to refer to my Section 84 again he will find that I have supposed nothing of the kind. If I had said the billionth of an ohm it would have expressed precisely the same meaning.

The experience which Colonel Bucknill has had in connection with the War Office conductors, and the attention he has for many years given to the protection of powder magazines, render his practical remarks very weighty. I regret they are at present so brief.

And now I come to the remarks of the President himself. For such of them as are personal, I may be permitted to express to him my thanks. There is one point—that with reference to Article 56—where I wish to explain my meaning more fully.

My statement runs, "Flat ribbon has a slight advantage over round rod, but not enough to override questions of convenience." Now it is of course perfectly true that extent of surface diminishes impedance, that Snow Harris's hollow tubes were better than Faraday's solid rods, and that if only one single stout conductor is to be used, then tape is distinctly its best, as indeed it is then also its most convenient, form. But I wished to obtain small self-induction by splitting up the conductor into detached portions, making each portion fairly thin. For these small conductors, also, no doubt ribbon is electrically better than wire. But will it last as long? Is iron ribbon easy to obtain? So long as common galvanised-iron telegraph wire is so easy to procure, it seemed a pity to insist on any other shape of cross-section, especially since a ribbon of corresponding cross-section would have to be so thin as to be very liable to rust away. All this I had in my mind in writing Section 56. I had so frequently insisted on the advantage of large surface in my theoretical Papers that I thought it permissible to throw it over in the practical portion for solely practical reasons, *i.e.*, because to insist on it to the bitter end seemed to entail trouble and expense.

But, it may be objected, why then did I say that tape had only a *slight* advantage over rod? Well, it is a matter of arithmetic to reckon how much better a given tape is than a given rod. If I make no mistake this is the result.

The self-induction of a rod of sectional radius, r, is to that of a strip of breadth, b, both being of same length, l, very nearly in the ratio

$$\frac{\log 2l - \log r - 1}{\log 2l - \log \frac{1}{4}b - 1},$$

the currents in each case being of such rapid frequency as keep to the outer surface.

Now, unless the rods are very short, or unless the breadth of the tape is enormous—its thinness being likewise excessive, if it is to consist of the same amount of metal as the rod—this ratio is not much greater than unity; and the same will be the ratio of their impedances.

Similarly the difference between hollow tube and solid rod is not of any *great* practical moment in lightning-rod circumstances.

With far lower frequencies, such as 100 per second, when frictional or dissipation resistance is the important part of total impedance, it is an altogether different matter, and the advantage of tube or plate over rod is then enormous, as Sir William Thomson has so thoroughly brought home to everybody.

Suppose, as rather an extreme case, the ratio of self-inductions for tape and rod were as great as 2, then the tape would have half the impedance of the rod for currents of the same frequency. Such a case I have experimented on; but I should not like to insist even then on the use of the tape in preference to the rod if there were serious practical objections on the score of cost, unsightliness, want of durability, &c., to be made against it.

If there are no such objections, then tape by all means, and the thinner and broader the better.*

It may be just borne in mind that decreasing the self-induction goes to increase the frequency, and hence that if ever the conductor forms a large portion of the entire path of discharge, the advantage of reducing its inertia is still less marked, for the impedance depends only on the square root of L in that case.

The President misunderstands me in one place, where he thinks I have said that it is no use connecting conductors to water mains. I do not know whence this misunderstanding can have arisen; possibly from section 59, where I say, "A good and deep earth should in general be provided, independent of water and gas mains." This may not be perfectly clear, but my meaning was as follows:—

Have at least one independent earth, made by a well or other suitable means, in addition to water main connections. In other words, do not depend *solely* on water main connections.

Probably this is a counsel of perfection for the case of ordinary dwelling-houses, but for an important building I think it may be wise, for these reasons:—Mains are near the surface, and in some weathers the soil near them may have become dry. Also they ramify into the house and into other people's houses, and will therefore conduct any violent charge communicated to them partly into these places, where, by a branch flash to a gas pipe, damage may be done and gas ignited.

I have shown that well earthed mains can thus give off unexpected sparks at a fair distance, even when only a Leyden jar discharge is run into them; hence I feel sure that some cases of damage result from lightning being thus brought underground into houses.

Having a good independent earth in addition to water mains is not indeed a *security* against this source of danger, but it is a step towards it. I do not propose to avoid the mains altogether, because in so many places it is not practicable. Whether you connect to them or not, the lightning will go to them if it chooses, unless they are far away; and it is better to give it an easy path rather than let it fly through air or soil, and knock, or melt, or burn a hole in them. It may sound absurd to talk of lightning knocking a hole; but the concussion of air is so great as to produce all the effects of an explosion. I entirely agree with Colonel Bucknill, that damage is most usually done wherever an air gap is jumped. I think compo-pipes are mostly melted where a flash jumps to or from them than where it simply passes along them.

With reference to the load of coke, I was under the impression that it was cheap and easy. It is not novel, and there are dozens of other well-known plans, if any are handier.

Lastly, I come to the most interesting topic of all—the cart-

* *See* Appendix II.

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ridges exploded in metal cases, mentioned by Colonel Armstrong (always provided that they were not merely ignited by heat), and the President's remarks thereupon.

Experiments on the effect of screens have gone on at intervals for some time in my laboratory. We can suspend a little elect trometer-like needle, charged positive at one end and negative at the other, inside a tinfoil-coated glass box, and can deflect i- by moving towards it a charged ebonite rod. But in order to succeed, the lid of the box must be so put on that a Léclanché cell shall not be able to ring a bell by conduction along the box. In other words, there must be a breach of continuity, or at least a very high resistance in the circuit. So soon as a Léclanché current can pass, no practicable motion of the ebonite rod can disturb the needle in the slightest degree. But there must be some limit to this. A stronger charge moved more quickly might do something so we have taken to firing charged bullets out of a miniature cannon towards the box. The bullets are no joke. They go slick through three inches of wood, and it takes a considerable thickness of earth to stop them. They can be charged and discharged, or reversed at appropriate stations, by passing through charged metal ; or they can be made to propel suddenly a permanently charged disc. But not a wink does the needle show. That only means that the tinfoil coating is too thick. We are going on to gold leaf, or a silver film, and so gradually thinning down till an effect is obtained. An effect *must* be forthcoming with a thin enough conductor, because one can go by gradual degrees to none at all. Liquid screens can, of course, also be employed, and probably quite a decent thickness of these will be fairly transparent. I would suggest, principally by way of query, that the action will be as follows :—

Let the resistance of a metal box to a current along it be R, then when a steady current (C) flows, a difference of potential (R C) will exist between its ends, whence electrostatic lines of force will radiate both inside and outside, and an electrometer needle inside will feel them. Now, instead of passing a current through the box, move an electrostatic charge, Q, with velocity, v, towards it. An electric displacement occurs which results in a momentary current, proportional to Q v, in the metal walls of the box, and to a slope of potential some specifiable fraction of R Q v which the needle may feel.

When a spark strike the box, a momentary current similarly exists in its coating.

Now, if the momentary current has no time to penetrate the entire thickness of the metal so as to flow in its innermost layers, then none of the slope of potential due to it can be felt inside the box, though outside it would be mixed up with the much greater direct action of the electrostatic charge. But if the covering is thin enough for some portion of the current to travel by its innermost layer, then an electrostatic disturbance will occur inside, which the needle, or a frog's leg, or a vacuum tube, or a microscopic spark gap, may be competent to feel. I may say, however, that frog's legs do not appear very sensitive to this class of effects. A zinc copper contact disturbs them vastly more.

Now, if the metal be iron, the depth to which the transient currents penetrate is very much less than it is in the case of non-magnetic metals ; hence a superficial layer, thick enough to make an effective screen if made of iron, might be a very imperfect screen if made of any non-magnetic metal. On the other hand, the resistance of iron is so immensely greater than that of non-magnetic metals to these transient currents, that if the layer were thin enough to permit an effect to be appreciated at all, the slope of potential to be felt might be greater than with copper, or even with tin or lead.

May I ask the President to be good enough to say if any or all of this is nonsense ? and, if it is not (being perhaps only what he instinctively had in his mind when he gave a hint about iron cages at Bath—the hint which he repeated in reply to Colonel Armstrong), then he will probably be able to calculate off-hand how much effect is to be expected in any given case, and to lay down rules whereby the disturbance liable to be felt through a given thickness of a definite metal can be at once calculated.

And now with respect to the "Practical Suggestions," which I provisionally made at the end of my Paper in order that they might receive the benefit of criticism, and between which and the main body of the Paper I have always drawn a clear distinction. Several have been criticised, and some have been shaken. May I quickly run over the list, indicating those which I still strongly uphold and those which I regard as doubtful ?

Nos. 51, 52, and 53, I suppose Mr. Symons would say, are "reprinted from the Lightning Rod Conference." They have, certainly, a fine ancient flavour of orthodoxy about them. But he would not have me throw over everything, both bad and good ! They seem to me good.

Nos. 54 and 55 I strongly uphold.

No. 56 I have indicated my reasons for provisionally maintaining. If they are bad reasons I trust the President will at once crush them out of existence.

No. 57 I regard as very important, especially its latter sentence. It is just one of the points wherein the rules of the future will differ from the rules of the past.

Nos. 59, 60, 61, 62 are very much open to discussion.

Nos. 63 and 64, I think, are sound. But very likely Colonel Bucknill's addition to 63 is an improvement.

No. 65 is very doubtful. There are, as Colonel Bucknill points out, very serious exceptions to it, even if it can ever be regarded as a rule.

Nos. 66 and 67 are sound, I think.

No. 68 is a fact. (This, Major Cardew will say, is "dogmatic." That also is a fact.)

No. 69 is a counsel of perfection : intended for powder magazines, not for dwelling-houses. Sir W. Thomson said it, or something like it, at Bath. It must be remembered, however, that "gasometers" are damaged when struck, according to reports in newspapers.

Nos. 70 and 71 are very doubtful. I throw them out as suggestions which experience must settle.

No. 72 is, I think, all right, but after the words "a load of coke" one may add, *or any of the well-known earth-contact arrangements.*

No. 73 has been wholesomely criticised. I think I am safe in still saying "it is not an unmixed good." But very likely the gain outweighs the loss. In fact, I have in the Mann lectures advocated the proceeding as good on the whole.

No. 74 I should be glad to be able to omit, but see no present chance of it.

Nos. 75 and 76 have been well criticised. I quite feel the force of the criticisms, and am glad to take refuge in No. 74. At the same time a righteous substitute for No. 76, if it be wrong, is very desirable. The middle part of No. 76 (a chimney with inside metal shaft) is a frequent and very difficult case. It embodies the advice which at present, for want of better, I give. Boiler firemen, engine tenders, and dynamos, would be apt to be damaged, I fear, if contrary advice were followed.

No. 77 is, I think, generally true, for such things as rain-water conduits under eaves, for picture rods, &c. ; not, of course, for a miscellaneous collection of metal objects.

No. 78 is, I think, right, if not too troublesome in practice. A crown of long points leaning well over into the smoke may do as well.

No. 79 probably belongs to Mr. Symons and the Lightning Rod Conference.

Nos. 80, 81, 82, 83 are intended to apply only to desperately important places : dynamite factories, petroleum tanks, and such like. They are, of course, perfectly open to criticism.

No. 84 is correct.

Nos. 85, 86, 87 are hints towards more elaborate methods of testing than the out-of-date plan at present in use. I call it out of date because it is based upon the untruth No. 57, and upon entire ignorance (very natural a few years back) of the great obstruction offered by good conductors. It is better than no testing at all, but it is extremely inadequate, in that it detects only one, and that a comparatively unimportant, kind of flaw.

Nos. 88, 89, 90, 91 have to do with lightning "protectors," and, I suppose, are orthodox and indubitable.

(To be continued.)

PARLIAMENTARY INTELLIGENCE.

The Select Committee of the House of Lords on the Metropolitan Electric Lighting Schemes.

THURSDAY, 8TH AUGUST.

Mr. FREEMAN, for the County Council, informed their Lordships that, subject to the preamble passing, it had been agreed between himself and Mr. Saunders to insert at the end of the first schedule ("area of supply") the words : "But excluding the following bridges over the River Thames, vested in the County Council, namely, Westminster, Lambeth, Vauxhall, and Chelsea."

Mr. SAUNDERS, Q.C., then continued his argument in favour of the Order granted by the Board of Trade to the Westminster Electric Supply Corporation.

The CHAIRMAN announced that the Committee were of opinion that the question of the Special Report by the Board of Trade which was raised on the first day was a matter which was not arguable.

Mr. LITTLER said he had hoped their lordships would not have decided that question without hearing him, as he felt sure he could convince the Committee that the special report had not been made.

Mr. SAUNDERS urged that the point had been argued on Tuesday.

The CHAIRMAN said he had announced the unanimous decision of the Committee, and they could not go further into this matter.

Mr. R. E. CROMPTON, C.E., of Messrs. Crompton and Co., was then called. In reply to Mr. Wallace, he said his company were the contractors

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to the Westminster Company. The first portion of the works was sufficient for a maximum supply of 5,000 10 candle-power lights; and the second portion was to be capable of supplying 85,000 lights. That second portion was to be for the lower half of the district to which the Order applied. The boilers required for 5,000 lights were in position and had been tested. One of the engines and dynamos had been tested and was at work. A large battery of accumulators had been put down and was just on completion, and all the switchboards and other plant required for a central station were also in position and practically ready for work. He would say that about three-fourths of the work for 5,000 lights was completed; and that they would be ready to supply those lights as soon as they could possibly lay down mains in the street. He had seen the site and the machinery of the opposing syndicate. As far as he could judge it appeared to be a quantity of boilers and machinery put down in a stable, which was all very well as a temporary means of supply, but the space available which, he was informed, could not be extended, was not sufficient to supply the quantity of light required to make central-station lighting pay.

Have you as a contractor to the company satisfied yourself as to the *bonâ fides* of the promoters and the responsibility of the undertaking?—I have satisfied myself that our money is safe.

Cross-examined by Mr. LITTLER: They had not commenced lighting at present. He believed the Syndicate had lighted one hotel. It was quite possible that the Syndicate was not only supplying 840 lights, but was under contract to supply 600 more. He was of opinion that the Syndicate had spent absolutely nothing on the site. He thought it was quite possible they had spent £2,000 or £2,500 on the machinery. One of the Westminster company's boilers, which was 40 horse-power, was a new one, and the other which was a 20 horse-power came from his other works. Those boilers were set up about six weeks ago. They were being got in when the company was before Major Marindin. They had also one Willan's engine and dynamo, both second-hand. The maximum output of their present appliances was about 1,200 lamps. The engine and dynamo both came from the Kensington Company. They were transferred to the Westminster because the Kensington did not want any more of the smaller dynamos.

Might I suggest it was in order to make a show that you were doing something?—No; they were no longer needed. As a matter of fact, they did not belong to the Kensington Company, but to us. It was customary to commence a station with small sets of plants, and the Westminster Company's station was put down in exactly the same way as the Kensington was started. There was room in their site for 2,800 horse power boilers. For the plant actually on the site his firm would receive altogether £4,700.

Mr. JOSEPH BROWNE MARTIN, in reply to Mr. SAUNDERS, said that he was one of the directors of the Westminster Company which was composed of people locally interested. He himself was a large freeholder in Westminster, and himself and two other members of the company paid about £9,000 a year in rates. The capital of the company was to be £100,000, and he had not the slightest doubt that if the Order was passed, they would be able to start the concern as a going concern. The Vestry of St. George's Hanover-square was supporting them in their district.

Have you any doubt whatever that if this Order is obtained in its present form you and your friends will be able to take up the whole of the capital?—Not the slightest. I and my friends are prepared to put in £50,000. If they do not put it in, I will put it in.

Mr. JAGO, Secretary to the Company, and Mr. JAMES LATIMER CLARK also gave evidence.

On behalf of the opponents, Mr. Littler then called Mr. THOMAS STANLEY PEACH, Chairman of the Syndicate, who produced the Memorandum and Articles of Association, and the register of the company. They had about 25 shareholders. £10,000 had been subscribed up to the present time—all paid up. They were registered within 11 days of the other company, but too late to go then for a Provisional Order. They had done a large amount of work beforehand. They were supplying about 1,500 lights, and had contracts for a good many more.

By the CHAIRMAN: They did not appear before Major Marindin because they were advised that without the consent of the Vestry, or without the approval of the Vestry, it was useless for them to make any application whatever, and therefore as they could not get the consent of the Vestry at that time, they decided that it was useless to put in an appearance.

Mr. COOPER, Electrical Engineer to the Syndicate, said the Company was incorporated in the month of July last year. They commenced lighting on the 15th September, and they had ever since that time supplied 750 lamps to the Hotel Windsor, at an agreed rental of £1,200 a year. They also supplied other customers, and had arranged to supply to St. Ermin's Mansions 230 lamps, and eventually about 1,600 to 2,000 by meter, or at £2 per lamp per annum. They had also arranged to supply the Member's Mansions for a period of eighteen months certain with 150 lamps at the rate of 30s. per lamp per annum. The Syndicate had expended no money whatever in wiring the buildings, and they had not canvassed for custom. About £4,400 had been spent on their electrical plant, including cost of machinery, cables, and the half-year's rent. They were charging on an average 7¾d. a unit. They had received from the vestry of St. Margaret's and St. John's, Westminster, their consent to the Syndicate applying for a license. He had visited the Westminster Company's works. He saw there a boiler which he took to be of 30 or 35 horse-power, and another one which might be of 20 horse-power. The 20 horse-power boiler was rather an old one. There was an engine there which had also apparently done a great deal of service, and a dynamo capable of giving current for about 500 lamps. The boilers were locomotive boilers, and might have cost a matter of £600 when they were new. The dynamos might have been a 20-unit machine or thereabouts, and might have cost something under £500 when new. The machine which they had was apparently a shunt-wound machine. He saw no cells, but the output of the machine would enable about 500 lamps to be supplied.

I suppose that apparatus would be sufficient to supply the one large building in which it was fixed?—Yes. I should think that the machinery that I saw would be very well suitable for lighting the Victoria Mansions. The room was not more than 15ft. wide, and the apparatus was only sufficient for the supply of the house in which it was. Unless they had a large number of cells, they had not more power that was necessary to light up Victoria Mansions.

Cross-examined by Mr. SAUNDERS: It was a mistake to say that they were supplying 1,500 lights; but they were under an agreement to supply 1,500 lights, and that number would be very much increased as the tenants applied in the buildings, which the Syndicate had got a monopoly to light. The actual maximum supply that they had at any time given was 880 lights.

Neither my scientific adviser nor myself can quite understand how £1,200 per annum for 750 lights is equivalent to 7¾d. per Board of Trade unit. Is it not the fact that that would be equivalent to 2s. per Board of Trade unit?—It is for a large number of lamps used all day, and in dark passages.

If Mr. Crompton's calculation is correct, that cannot make the difference, unless you use it three times as long as the ordinary house term?—I understood the question to be what our price was per meter.

It must not be supposed that the Windsor Hotel is getting the benefit of that 7¾d. rate?—It is not.

What is it that you are afraid of if we get our Provisional Order, and carry it out?—We believe that your company intends to run on the three-wire system as a permanent engineering work, and we intend to do the same, and we apprehend that the two companies supplying on the same system will not be allowed to compete in one and the same district.

In other words, you apprehend that it is either your company or our company that is to supply the district, and not both?—That is so.

In reply to further questions, WITNESS said that he did not go into the storage battery room of the promoters' works. He believed that they had 60 cells, but he did not see them. His own company had a storage battery, not in their works but at the Windsor Hotel, by means of which they supplied other consumers besides the hotel. The company was not connected with the Hotel Company, but in order to enable them to supply their customers all day and all night, and to avoid running the machinery with an extremely light load the whole 24 hours, they had one battery which was sufficient to do all the night lighting at the Hotel Windsor, and also to meet any call that might be made upon it by any of their other customers. The battery was placed in the Hotel Windsor because they were offered a very convenient position, but they had space for it in their own premises, and he wished that it was on their own premises now.

Re-examined by Mr. LITTLER: Works for works, which of the two at this date is most capable of supplying electricity?—Our Company.

By the COMMITTEE: They could not pretend to do as much on their site of a quarter of an acre as could be done by other people on a site of half-an-acre, but in selecting their site they were of opinion that with the space they had at present and the space they had the right to acquire, there would be room enough to meet all the requirements of lighting the district. They considered they could put down plant for 90,000 10-candle lamps.

Mr. SAUNDERS informed the Committee that as the Order was not opposed with regard to St. George's, Hanover-square, he had not gone into the circumstances in that district; but as a fact they had in that district a variety of other sites which would be interchangeable to supply the whole district.

Mr. PEACH (recalled), in answer to the CHAIRMAN, further explained that the reason why the Syndicate did not appear at the Board of Trade Inquiry to oppose the application for a Provisional Order by the Westminster Company was because they believed that without the approval of the Vestry or the consent of the local authority no Provisional Order or License would have been granted, and also because they did not think that the other Company were at all earnest in their endeavours to go on. They thought it was more or less what is called in America a "bluff," because the other Company made several overtures to his Company to join them.

The CHAIRMAN: I would point out that they might have appeared to oppose as persons locally interested.

Mr. LITTLER: I am bound to say, my lord, from what I know of local inquiries, that I should have advised them not to oppose. It is a great waste of time and of money too, because if they want to oppose they have to come here afterwards.

The WITNESS: We believed that that inquiry would end in nothing, and we did not want our shareholders' money to be wasted in attending those sort of things.

Mr. LITTLER then addressed their lordships on behalf of the Westminster Syndicate, contending that if the Order was refused to the Westminster Company the promoters would really lose nothing, but if it was granted the Syndicate would virtually lose the whole of the money they had spent; they would, in fact, suffer annihilation. The Syndicate was at the present moment the only electric company which was supplying the district. They were increasing their lighting orders every day, and were in a position to-morrow to supply light. The promoters were not. They had only started to attempt to supply. Was it intended that an Order should pass under such circumstances? The Syndicate had actually put down £10,000, but the promoting company had only put down £35, and the Syndicate was now being asked to sacrifice their £10,000 in order to make the promoters' £35 worth £25,000. That is what the Committee were asked to do at the instance of gentlemen who had done nothing until they thought they were tolerably safe, and now the company was stepping in, not only to destroy the £10,000 which his clients had put down, but to reap all the benefit from their efforts.

Mr. SAUNDERS replied, contending that the points raised by Mr Littler should have been raised before Major Marindin.

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The Committee, having deliberated in private, decided to go on with the Order.

Mr. LITTLER then on behalf of the Syndicate asked the Committee to insert the following clause in the Order, which was similar to a clause which the London Company had agreed to give them :—"The Undertakers will not directly or indirectly oppose the procuring of a License or Provisional Order by the City of Westminster Electrical Syndicate (Limited), except so far as such License or Order may physically interfere with the works of the Undertakers, and the securing of protection from such interference." He said that such a clause was necessary to protect his clients from ruin. The £100,000 of capital which the promoters of the Westminster Company were entitled to raise would not be sufficient for the large area they proposed to supply, and that was all the more reason why his clients should be allowed to remain in the district.

Mr. SAUNDERS, for the promoters, stated that the clause had been accepted by the London Company by arrangement only, and he should object very strongly to its being compulsorily put upon his clients. The mode of supply adopted by the Syndicate was different in character to that adopted by the London Company, and therefore they would come within the definition of Major Marindin's report of two companies supplying by different systems for the purpose of competing and trying the two systems together side by side in the same district—one admittedly capable of giving motive power, the other doubtful upon that point. Both his clients and the Syndicate were equally capable of supplying motive-power, as they supplied by the direct current, and therefore there could be no real reason whatever why the two companies should have concurrent rights of supply in the same district. The principle upon which the Board of Trade had gone hitherto was not to give more than two companies the right to supply in the same district, and his clients could not therefore be put in the same category with the London Company, for the reason that if they were to do anything which would have the effect of admitting the Syndicate there, they would be doing that which the Board of Trade themselves did not approve of. He did not think such an arrangement as that now asked had ever been effected compulsorily, but he knew it had been done by agreement.

Mr. LITTLER, in reply, said that it had been done compulsorily, and added that he was quite ready in the proposed clause to put the words, "on the ground of competition."

The room was then cleared, and the Committee deliberated in private.

On the counsel and parties being called in,

The CHAIRMAN said: The Committee are not prepared to insert the clause.

The clauses of the Order were then gone through and agreed to, and the Committee closed.

HOUSE OF LORDS.—THURSDAY, AUGUST 15.

Yesterday, in the House of Lords, on the third reading of the Electric Lighting Provisional Orders (Nos. 2, 3, 4 and 5) Bills,

LORD CRAWFORD said although very great care had been exercised in drawing up these Bills still, in the course of time, they would have to be amended by their lordships. The parts of the Bills that would require amendment were the meter clauses and the testing clauses, and all those who had anything to do with electric lighting knew that they were unworkable. They were drawn up in 1882, when the first legislation on this subject took place, and they had been copied almost verbatim in the present Orders. They had had no time to modify them because nobody knew how to modify them. They were quite unworkable, and although he wished to recognise that great trouble had been taken over these Orders, still they could not be taken as final.

The EARL of LIMERICK said his noble friend would not expect him to go into this subject. These Bills were opposed before a Private Bill Committee, and it was agreed that this question of the meter should not be raised before the Committee. As his noble friend had said, it was a question for the future, and it had been put by his noble friend rather as a saving clause than as anticipating any action at present by their lordships' House.

The Bills were then passed.

THE BRUSSELS ELECTRIC TRAMWAY.

On the occasion of the visit of a party of electrical engineers to Brussels, for the purpose of studying the working of the electric tramways, which have now been running there for two years, M. G. Michelet, Director of the Brussels Tramway Company, read a Paper upon the experience gained during these two years. The following is the substance of M. Michelet's remarks :—The system adopted in Brussels is, as is well known, the Julien, and the promoters of this system stated in their prospectus that the tractional expenses would not exceed 16 centimes per car kilometre, this figure being calculated to apply to certain fixed lines in the Quartier Léopold, and on the assumption that the depôt in Rue Juste Lipse was to be arranged for the working. The Brussels Tramway Company, on the other hand, estimated the cost of working the lines in question, with two-horse cars, at 25 centimes per kilometre. The difference in cost was so great that had the calculations of the electrical promoters been true a great saving would have been effected. Experience soon proved that the batteries first employed were too weak. They were so rapidly destroyed that the duration of the experiments became a mere question of time. Experience taught us that the working of the tram in the Rue de la Loi, with a gradient of 1 in 30, requires a current of 30 amperes, and that in the Rue Juste Lipse, with a gradient of 1 in 25 for a distance of 480 metres, one of 40 amperes. It was therefore necessary to have cells weighing from 20 to 25 kilogrammes if the accumulators were only to develop two amperes per kilogramme, the allowable maximum. With regard to the electrical machinery, we are at present using dynamos of English construction, which answer very well. The cost of maintenance, however, still remains very high, and we are far from having attained the results anticipated. Thus, the expense of maintaining the accumulators, which was estimated at 3·51 centimes per car kilometre, costs at present 9 centimes, whilst the maintenance of the car motor and the transmission apparatus was estimated at 2·16 centimes, but is, in fact, 5·74 centimes ; in short, general expenses of every kind, except *employés*, are about 25 centimes per car kilometre, or very nearly the same as for working by horses. There is, therefore, on taking into consideration the maintenance of the stationary engines, royalties to the inventor, interest on the capital sunk, besides depreciation of fixed and rolling stock, a loss in working by electricity. The Brussels Tramway Company at present maintain only three electrical cars at work, though the installation is capable of working eight cars. In order to ascertain with perfect accuracy the expenses of the working the most minute control was instituted. During the past six months the Brussels electrical trams have run 61,088 kilometres, or 288 kilometres daily, and on this running the figures are based. It has been found very difficult to fix exactly the expenses of maintaining and renewing the accumulators. We estimate at present that the accumulators before requiring renewing are capable of working 8,000 kilometres, or 200 days ; at the end of this period they have to be taken to pieces and the positive plates renewed. The most careful attention has been given to this operation, and we have come to the conclusion that the expenses amount to 10 centimes per kilometre run. A special account has been opened for every battery where they have been credited every month with 10 centimes per kilometre run until the value has been reduced to that of the materials remaining. On the other hand, the account has been debited with all expenses of maintenance and renewal. The result of this careful bookkeeping in connection with monthly stock-takings is that the expenses of maintenance of the accumulators has been 9 centimes per kilometre. Our present efforts are wholly concentrated upon reducing the cost of maintenance of the accumulators and in improving the electric and mechanical apparatus. M. Michelet concluded by saying that he considered electric traction still in its infancy, and that practical experience had by no means justified the sanguine tone adopted at the Antwerp trials of a few years ago.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August* 3, 1889.

The march of events in this country is generally rapid, and a remarkable evidence of the speed with which changes and transformations occur has just been given in the action of the West-End Railway Company of Boston in regard to the wholesale adoption of electricity for its enormous system in Boston. Less than two years ago, shortly after the time when the street railway systems of Boston became concentrated under one management, Mr. H. M. Whitney, the president of the road, an energetic, enterprising, and far-sighted man, thought it worth while to experiment with electricity. He had noticed the improvements that were being made in electric motors, and had been somewhat impressed with the reports that reached him as to the successful operation of the few roads started. As was natural, his first impression was that the use of the storage battery would solve the problem for Boston. The horse-car service had been found inadequate, the use of the cable was almost out of the question in a city with so many winding streets, the prejudice against overhead wires was strong, electric conduit systems had been by no means perfected, and the choice, if choice it could be called, narrowed itself down to storage batteries. Mr. Whitney thereupon began to experiment, and proceeded to see what storage batteries could do. Somehow or other, and although the tests were in good hands, he did not derive much satisfaction from them, but while the use of electricity in this particular form disappointed him and his associates, they were convinced that the overhead

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system, whose success had meanwhile been strikingly exemplified at Richmond, would answer their purpose. Accordingly, one or two of the suburban lines were equipped, first with the Sprague and Bentley-Knight systems, and then with the Thomson-Houston. The result has been that after a trial of five to six months the West-End Company has unanimously voted to increase its capital stock by four and a-half million dollars, in order to equip its whole system electrically. The reasons which Mr. Whitney presents for this highly important and significant step must be regarded as more than ample. To begin with, he shows that the cars operated by the overhead wires in Boston make one-eighth faster time than do the trains on the elevated roads in New York. Moreover, there has been a remarkable saving in the cost of motive-power. With horses, power has cost over ten cents per mile, whereas on the Alston electric line, in spite of much leakage on the section of conduit used, the cost has not exceeded five cents per mile, although, as has been noted, a much higher rate of speed than formerly has been attained. Then, as to the increase of travel, some wonderful statistics are given by Mr. Whitney in the able speech which he made before the West-End stockholders last week. On the Arlington electric line the traffic has shown an increase of 150 per cent. in seventeen days. Of course, it might be said that this was simply due to the novelty of the thing, but electric roads are not a novelty now in Boston. Moreover, on the Cambridge electric road, which has been running since 1st February, the increase in traffic reaches the astounding figure of over 300 per cent. Nothing could speak more strongly as to the boon which has been conferred by electric locomotion upon the citizens of Boston and its suburbs. In fact, Mr. Whitney appeals to the inhabitants for confirmation as to the statements that he makes about the greater comfort and convenience offered by the electric service. It might be expected that considerable opposition would be developed against the use of overhead wires, and, in fact, there has been a great deal of trouble on that score. But it does not come from the leading newspapers nor from the mass of the people. The overhead electric railway wires in Boston are practically unnoticed. I have myself ridden on the electric railroads there, and although I am pretty familiar with the electric roads in this country, I must confess that in Boston city, as well as in the outlying regions and in other places like Richmond, it is often difficult to discover at all the presence of the wires. In some of the Boston suburbs, too, the tracks, as well as the overhead systems, elude observation in an extraordinary manner. While the wires run through the trees the tracks are laid along stretches of green sward, with the grass growing beneath them, so that at a few paces' distance the rails cannot be seen at all. The effect is that of a car running upon grass without anything whatever to propel it. The cars on the various branches as soon as they escape the city limits are speeded up until they make from 10 to 15 miles an hour. The result is that the residents in the suburbs of Boston reached by the electric system are much nearer their business offices than they who live up town in New York along the line of the elevated roads. Another important point that Mr. Whitney touched upon was the depreciation of rolling stock. He showed that in spite of the defects naturally incident to a system that may be said to have reached a practical shape only within the last two years, the repairs and depreciation were quite low, and would compare very favourably with the depreciation on account of horses. The West-End Company has now to write off every year no less a sum than $150,000 for depreciation of its animal power. Allowing that the company paid the high price of $150 per horse, this would mean that at least a thousand horses a year are lost, or one in every seven, and we know very well that the improved electric motor can make a much better showing than that. It now remains to be seen what will be the result elsewhere of the action taken in Boston. In New York it is very unlikely that the overhead system will be adopted, but there are many other large cities throughout the country where the action of a crowded and conservative place like Boston will have a marked effect in hastening the adoption of electric roads with overhead wires. The street railway companies will certainly be stimulated by the statement made by Mr. Whitney that while the electric roads had been showing this enormous increase in traffic, the increase under the old system of horses had been only 10 per cent. annually. A more striking demonstration of the manner in which the use of electricity has fostered and developed travel cannot possibly be afforded.

In a recent letter I mentioned the fact that the Postmaster-General, exercising the power conferred upon him by an old Act, of regulating and revising the rates paid by the Government to the telegraph companies for official business, had cut down the tariff this year to the absurd figure of one mill per word, or one-tenth of what it had been before. Even at the old rate of a cent a word, the telegraph companies were by no means overpaid, but the new rate is not even enough to pay the messenger delivering the telegrams. It need not be wondered, therefore, that the Western Union Company has made a very stout protest against this new Government tariff. Postmaster-General Wannamaker has sought to justify his action by claiming that he was getting no more than others got, by which he is supposed to refer to the News Associations and to the railway companies; but even in this respect he is wrong. It is true that the telegraph companies have a limited free service for railway companies, but it is paid for in a variety of ways, including free transportation and maintenance of lines and the service of the railroad operators. With respect to the transmission of news, it is pointed out by Dr. Norvin Green that this is not exacting and that it is done mostly at night when the wires are clear. As Dr. Green says, outside of this the Western Union makes no reduced rates to any corporations or other patrons, large or small. For messages transmitted and delivered to a single address the Government is the only customer enjoying reduced rates. As for the claim that the company derives great benefits and privileges under the Act of 1866, Dr. Green replies that they are purely imaginary, and where occasion has arisen to cross Government land, the company has had more trouble and delay than if the property had belonged to private parties. The Western Union Company, in its fight against the Postmaster-General, has enjoyed the support of many of the journals that are noted as a general thing for their readiness to take up the cudgels against the company, and hence it may be hoped that the justice of the protest will be admitted and that the old rate will be restored. Otherwise, it will hardly pay the Western Union Company or any other telegraph company to make a book record of the Government business. It would be better to save money by not attempting to collect the paltry sum that the whole business would amount to in a year.

Many of your readers will, doubtless, be interested to hear that the Electrical Exhibition, which has just been held at St. John, New Brunswick, is voted by those who have seen it very much of a success. It is said that this is the first electrical exhibition ever held in a British Colony, and whether that be so or not, it is decidedly creditable to the city of St. John, in which it has been serving as one of the means of celebrating the practical completion of the Canadian Pacific Railway, which now gives Canada a road from the Atlantic to the Pacific. Its remarkable feature, however, as illustrating the closeness of business relations between this country and Canada, is that the Exhibition is largely made up of American manufacturers. In fact, the leading exhibits are those of the Edison and Brush companies. Although St. John is in many senses a remote place, it has a good appreciation of electrical applications. It has a good telegraph and telephone service, and already has two arc light plants, one Brush and the other Thomson-Houston, the latter being operated by the Gas Company. It is now stated that one of the results of the Exhibition will be that a new incandescent plant for general supply will be established in the city. Speaking of Exhibitions reminds me that electricity is playing a leading part in shows going on or projected at Detroit, Michigan, and Dallas, Texas, and that already over one thousand exhibitors have engaged space for the Electrical Exhibition to be given next month at St. Louis. All these efforts are excellent and do much to promote the welfare of electrical industries, but they will sink into utter insignificance alongside of the display which will undoubtedly be made in this city in 1892 on the occasion of the Exhibition to celebrate the discovery of America by Columbus, four hundred years ago. After all, Columbus did not do any more for

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the race than such men as Morse, Edison and Bell have done, and it is fitting that the great feature of the Exhibition of 1892 should be the bringing together of all the electrical inventions and improvements of the century.

Next week the electric light men are all going off on a junketing trip to Niagara Falls to attend the meeting of the National Electric Light Convention. A very interesting programme of Papers and topics of discussion has been prepared, but, as the ladies also turn out in force on this occasion, I have no doubt that a great many of the members will find it more necessary to study the question of utilising the vast water power of Niagara by excursions out to the "Three Sisters" and trips on the "Maid of the Mist" than by exchanging experiences in a dusty and stifling hall. These meetings have a very good effect in bringing men together from all parts of the country to exchange ideas, and the benefits that are derived are not to be judged of merely from the list of Papers, no matter how vital may be the topics or how prominent the authors. In point of fact, a man would very often learn of more to his advantage at such a meeting from the merest casual conversation with his fellows than from the long discussions that may take place in regular session, where many of the men are afraid to speak out lest their facts and figures should get into print, and so "give away the business." I think that the rapid growth of electric lighting in this country may be in a great measure attributed to these gatherings, and I have no doubt that sooner or later something of the same kind will be tried with advantage in England, where by this time there ought to be, it would seem, enough encouragement in the electric lighting industry to constitute the nucleus of a convention of the kind we are now so familiar with here.

CORRESPONDENCE.

THE KNOWLES STORAGE CELL PLATE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 9th you call attention to a form of "storage cell plate" and a so-called "system" claimed by the Mutual Electric Manufacturing Company, the supposed chief points of novelty being described as:—

1. The use of a compound plate made by rivetting together two perforated sheets of lead with the active material packed between them.
2. An inoxidisable alloy.
3. An arrangement for working arc lamps and charging storage batteries with the same dynamo and conductor.

I would venture to point out, as to the first point, that such a compound plate is fully described and illustrated in my patent of September 10th, 1881, No. 3,926. As to the second, that the only inoxidisable alloy of a practicable nature for such work known up to the present time is formed of lead and antimony, described and patented by me under date September 15th, 1881, No. 3,987; and as to the third, I would refer those interested to my patent No. 217, 13th January, 1883, for "working and regulating secondary batteries," in which, under the head relating to circuits, in which there is a combination of arc and incandescent lamps and accumulators, I fully describe an arrangement which, so far as I gather from your brief description, anticipates that referred to.

With regard to the absence of "buckling and sulphating" claimed for the "novel" form of plate, surely the time is long passed for putting forward these bugbears. Any manufacturer who understands and attends to his business will send out plates properly made and fully "formed," and such plates, worked under well known and simple rules of treatment, will never buckle or sulphate injuriously, whilst, on the other hand, *no form of plate whatever* will escape one or other of these evils if either badly made in the first instance or badly treated afterwards.

Plates of the ordinary E.P.S. type, made early in 1882, have worked continuously and at full duty for many years without ever showing the least sign either of buckling or of becoming unduly sulphated, evidencing that any so-called recent improvements in manufacture have little to do with the prevention of these easily avoidable troubles.—Yours, &c.,

Sydenham, August 12th, 1889. JOHN S. SELLON.

MR. MORDEY'S PAPER AND THE DISCUSSION ON ALTERNATE-CURRENT WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 2nd inst. I notice a reproduction of Mr. Mordey's reply to the discussion on his Paper, "Alternate-Current Working," in which he quotes two statements from my writings for the sake of demonstrating some contradiction between them.

To this I beg leave to oppose that, in fact, there does not exist any contradiction at all. By saying, "we state that we have not reduced the periodicity because of the coupling in parallel," I purposed only to declare that we absolutely have not *reduced* the periodicity, *as, indeed, there did not exist any necessity at all for us to reduce it.* I observed a periodicity of 42, or nearly so, in my dynamos at a time when the idea of running alternating machines parallel was as yet unknown, because the necessity of so coupling them was not recognised until after the introduction of the tranformer system. The experiments which we afterwards made with coupling in parallel showed that the periodicity above mentioned proved advantageous, among other things, *for the coupling in parallel* of my machines. Now, nothing was more natural for me than to preserve this periodicity, the other advantages of which were already well known to me from experiments dating from a period when Mr. Mordey's own work had not yet reached publicity.

As for our silence on the particulars of our alternate-current motor, we fully agree with Mr. Mordey's opinion, that "there are no doubt good and sufficient reasons for this reticence"!—Yours, &c., CHAS. ZIPERNOWSKI.

Budapest, Aug. 7, 1889.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you permit me to make a few remarks relating to Mr. Mordey's pioneer Paper and the discussion on the above subject? After reading through the Paper, discussion, and Mr. Mordey's reply as printed in the *Journal* of the Society of Electrical Engineers and Electricians, it seemed to me strange that at least some of the contested points should not have been settled in the minds of the members. But the theorists remained apparently unconvinced. Parental affection is very strong, and no doubt some members felt it too terrible to part so suddenly with their cherished offspring. No doubt, also, it is much easier to grasp the full meaning of the various speakers from their (presumably) recomposed remarks than when listening to them in succession, and I may, therefore, be whipping a dead horse in writing this letter, in which case I can only ask pardon for trespassing on your space.

In the absence of any statement from Mr. Mordey as to the strength of the current which passed between and through the armatures of the two machines when one was excited to 1,000 and the other to 2,000 volts, it appears safe to infer that it was not measured. We know, however, that the resistance and the self-induction of the armature were both very low (else how, indeed, could they have run together so perfectly?!) It thus appears that a "prodigious current" (to use the Presidenth expression) would be produced through the two armatures wit's but a comparatively trifling difference of E.M.F., and what was wanting in number of turns to produce demagnetisation of the poles would be amply made up by an enormous current.

As regards the objection made by Prof. S. P. Thompson and concurred with by Mr. Mordey at the time of his reply, *i.e.*, that the time ($\frac{1}{200}$ of a second) must be insufficient for a coil to take effect on the solid pole-piece, I think Prof. Thompson would not argue that the effect of the coil flying past at such a speed would be *nil? But*, the same cause which prevented the flying coil from instantly reducing the magnetisation to the value due to the component magnetising forces—self-induction, would also prevent the pole from recovering to its former strength before a second coil flies past and reduces the magnetisation a degree lower, and in this manner the pole strength will rapidly be reduced nearly to the value due to the compo-

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nent magnetising force. In short, we have not to consider the effect of a single coil, but the cumulative effect of the whole, and I take it that the demagnetising force will be operating during a large proportion of the time.

Unless Mr. Mordey is able to state definitely that an unusually heavy current did not pass, I therefore think the President's explanation of the experiment is probably the true one.

It may be noted that this unusually heavy current (if it existed) might easily have escaped detection if unsuspected at the time of the experiment, especially if the conductors were large or the time of the experiment too short to allow of unusual heating; one reason being of course that the current through so small a resistance would not represent sufficient energy to show on the bands, another that the absence of even ring collectors in the Mordey alternator removes the possibility of a "splash" with even a prodigious current unless it were sufficient to fuse the conductor at some point.

Mr. Mordey charged the theorists with having neglected in their investigations the actions which take place in the field magnets. It appears to me that these actions will be very much more important in the case of machines with iron cores in their armatures than in those without. In the Mordey alternator and in others with no iron in the armatures the magnetic circuit in the fields remains uncharged except for the influence exerted by the current flowing in the armature coils. In the case of machines with iron in the armatures the field magnets are varying rapidly from "open" to nearly "closed" magnetic circuits, so that unless the field cores are nearly saturated when the magnetic circuit is "open," although self-induction will prevent the magnetisation of the poles from fluctuating between the two values which it would have if the field magnets were stationary in the two positions respectively, the field will be very unstable, and the machine consequently a bad regulator.

Mr. Mordey in his supplementary remarks describes a new alternator upon which I should like to say a word, and which I think bears upon Prof. Forbes' experience with a machine of similar design, *i.e.*, that it is almost a continuous-current machine.

In this machine the outside core bars are subject to no direct demagnetising influence when the magnet poles have passed them, but, on the other hand, have a splendid leakage circuit through the inside core bars, which are magnetised in the correct sense to assist the armature current in maintaining the magnetisation.

Now the demagnetisation of the outside bars is the vital point in the action of the machine, the magnetisation and demagnetisation of the inside core bars being practically without effect on the armature coil. It therefore appears that a greatly improved effect would be obtained by substituting for the single magnet a number of smaller magnets with alternately reversed poles, such as are more usually employed in alternators.

I trust we shall before long be favoured with Mr. Raworth's experimentally plotted curves of the currents in the Mordey alternator and transformer.—Yours, &c., W. B. SAYER.

Lisbon, 8th August, 1887.

MR. LANE-FOX AND THE ANGLO-AMERICAN BRUSH CORPORATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We enclose, at Mr. Lane-Fox's request, a copy of his remarks at the Brush Company's meeting to-day.

We may add that Mr. Lane-Fox has nominated Mr. Slade, Mr. Drake, and Mr. Gorham to carry on the negotiations on his behalf with the Brush Company.—Yours, &c.

DRAKE AND GORHAM.

2, Princes Mansions, Victoria-street, London, S.W.,
August 14th, 1889.

[COPY.]

I think it only right to mention that I have certain unsettled claims against the Brush Company.

The liquidation of the company make it imperative that these differences should now be dealt with, and I am afraid that unless we can come to an immediate understanding the whole question of my early connection with the Brush Company down to the present will have to be reconsidered.

I have done everything that was possible to get them settled amicably. Hitherto, however, I have allowed myself to be put off with vague assurances.

I should add that quite recently a very equitable proposal has been submitted to them on lines which, I understood from the manager, they were willing to agree to, but as I have not received from them any satisfactory assurance of a settlement I am compelled to refer to the matter at this meeting.

THE K.M.B. POCKET GALVANOMETER.

A combined detector galvanometer and ammeter has been brought out by Messrs. King, Mendham and Co., of Bristol. The galvanometer is made in two distinct parts. The front portion carries the needle and graduated dial, and is capable of rotation round its centre, its edge being milled to admit of easy movement; the back part contains the bobbins, which are wound to two measured resist-

FIG. 1.

ances. One half of the dial is graduated in degrees while the other portion represents an equally divided ampere, and the dial may be rotated so as to bring either half uppermost, the needle, of course, remaining in a vertical position. That part of the dial graduated in degrees is used uppermost when it is required merely to test a line wire or a battery, as with an ordinary detector galvanometer. The

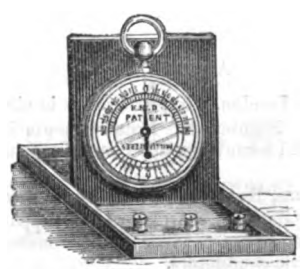

FIG. 2.

other portion of the dial is used uppermost when it is desired to find the strength of the current, which is indicated in milliamperes. In Fig. 1 the instrument is shown with its two graduations, that part divided into degrees being uppermost. Galvanometers are also supplied in cases, as shown in Fig. 2. This is so arranged that the vertical portion against which the instrument is fixed is removable,

FIG. 3.

and fits down into the tray, which gives it the protection it requires; the galvanometer can thus be carried in the tool bag without fear of being damaged. Another method adopted for mounting the galvanometer is represented in Fig. 3, and so mounted it can be used as a laboratory galvanometer.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

July 30, 1889.

12,046. F. MARQUARD. London. Improved composition adapted to electric insulators and other articles and uses in the arts and manufactures.

12,047. The Hon. F. D. LEIGH. London. A mode of rendering the knobs or buttons of electric bells, electric switches, and suchlike luminous in the dark.

12,066. T. W. WATSON and A. H. WATSON. London. An electric hand signalling lamp.

12,082. A. J. JARMAN. London. Improvements in the arrangement and regulation of electric motors for traction, marine propulsion, and suchlike purposes.

July 31, 1889.

12,135. W. E. HEYS. Manchester. Improvements in electric cut-outs, and apparatus for opening electric circuits (N. Chaize and J. Chaize, France).

12,145. P. M. JUSTICE. London. Improvements in generating electricity or magnetism by the application of heat (E. G. Acheson, United States).

12,153. G. BROOK. Huddersfield. A new or improved application of electric call-bells or gongs to tables or other articles of furniture in hotels, refreshment rooms, and similar places of refreshment or amusement.

12,161. J. J. PERKINS. Spitalfields. Electric alarm rug or mat.

12,185. A. H. HOWARD. London. An improved mode of distributing electricity.

12,188. H. H. LAKE. London. Improvements in apparatus for regulating and utilising electric currents (F. V. Maquaire, France).

August 1, 1889.

12,236. J. SWINBURNE. Wimbledon. Improvements in appliances for the generation, distribution, measurement, and use of alternating or commutated electric currents.

12,237. J. SWINBURNE. Wimbledon. Improvements in and connected with electric transformers.

August 2, 1889.

12,251. J. A. TIMMIS. London. Improvements in electric couplers.

12,270. H. J. PEDDIE. Edinburgh. Improvements in apparatus for electrical sight and sound signalling on railways and in mines and coal-pits.

12,286. Sir C. S. FORBES, Bart. London. An electric current meter.

12,313. H. LEA. London. Improvements in apparatus for regulating and maintaining constant or nearly constant the electromotive force in electric conductors.

12,331. F. KING and W. P. MENDHAM. Bristol. Improvements in self-adjusting electric pendulum indicators.

SPECIFICATIONS PUBLISHED.

1888.

12,832. ANDERSEN. Dynamo electric machines. (Price 8d.)

12,963. ZIGANG. Telephone. (Price 8d.)

13,000A. SARGEANT and SWETE. Making electric contacts. (Price 6d.)

13,208. WELLS. Electric lights. (Price 6d.)

1889.

1,118. SPERRY. Electric switch. (Price 8d.)

5,084. BOULT (Pouchard). Electric clocks. (Price 8d.)

6,854. LEONARD. Electrically lighting trains. (Price 8d.)

7,215. ASKEW and PUMPELLY. Secondary batteries. (Price 8d.)

7,992. ALLISON (Robertson). Combined telephony and telegraphy. (Price 6d.)

8,456. BRISTOL. Portable electric safety lamps. (Price 6d.)

8,856. LAKE (Ball and others). Separating magnetic ores. (Price 8d.)

9,638. DRAKE. Telephonic, &c., transmitters. (Price 6d.)

COMPANIES' MEETINGS & REPORTS.

Anglo-American Brush Electric Light Corporation (Limited).

An adjourned extraordinary general meeting of the shareholders of the Anglo-American Brush Electric Light Corporation (Limited) was held at the office of the Corporation, 112, Belvedere-road, Lambeth, on Wednesday last, under the presidency of Mr. J. S. Sellon, in the unavoidable absence of Lord Thurlow.

The CHAIRMAN briefly explained that the meeting was called merely to confirm the resolutions passed at the extraordinary general meeting held on the 26th of July, fully reported in *The Electrician* of that date.

The resolutions referred to were then put *seriatim* and unanimously confirmed.

[For the resolutions which this meeting was called to confirm see *The Electrician*, August 2, 1889, p. 339.]

City of London and Southwark Subway Company.

The tenth ordinary general meeting of the proprietors of this Company was held at Winchester House, Old Broad-street, E.C., on Tuesday last, for the purpose of receiving the report of the Directors and statement of accounts for the half-year ended June 30th, 1889, and the transaction of the ordinary business of the Company. Mr. C. Grey Mott, the Chairman of the Company, presided.

Mr. H. H. M. SMITH, the secretary, read the notice calling the meeting.

The report of the Directors (which was taken as read) stated—"The boiler-house at the Stockwell depôt is approaching completion, and the boilers are being placed in position. The other works at this depôt in connection with the electric supply, the hydraulic power for working the lifts, the carriage sheds and workshops, are also making good progress."

The CHAIRMAN, in moving the adoption of the report, said that since the date of their last meeting they had carried out some very important works without any serious accident whatever, and at the present time the whole of the tunnelling, with the exception of a short piece between the Oval and Stockwell, where they had met with a bed of wet gravel, had been completed. The underground works at three of their stations had been

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.

PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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finished, and at the three others were in course of completion ; the surface stations at Great Dover-street and Elephant and Castle had also been finished, and the alterations at the City station at King William-street were being pushed forward. The engines and carriages for the experimental trial were in the tunnel now, and they hoped that in the course of a very short time, the first trial (which would be on behalf of the contractors) would take place. After that the actual preliminary trial would be made. They had, as the shareholders knew, acquired a fine piece of land at Stockwell, the terminus of the line, upon which they were erecting the needful buildings and were also putting up the machinery for working the electrical plant to give the motive-power, and also the machinery for the hydraulic lifts. The whole of the machinery would be completed and ready by the time they had got through the wet gravel, which work was slowly progressing. The rails were laid for the full length in one tunnel and for a great part of the distance in the other. When he met the shareholders six months ago he expressed the hope that at this meeting he would be able to announce either that the line was open for traffic or else to fix the date when that opening would take place, and he could assure them that no one regretted more than he and his colleagues did that any further delay should have taken place ; but it had to be borne in mind that theirs was an entirely novel undertaking in every respect, not only as regarded construction, but also motive-power. The results achieved, he thought, reflected the greatest credit on the contractors, engineers, and all concerned. Since the date of the last meeting they had raised additional capital to the extent of £75,000, which they believed would be ample. They had not done this by public advertisement, but by arrangement with financial houses in the City ; this had, of course, entailed expenses in the way of commission and concessions in price, but they had saved the advertising bill. They had pushed forward the line as rapidly as possible, and they trusted that they would within a very short space of time be in a position to open it throughout from the City to Stockwell. Everything had been done in such a way as to render failure, when the opening was accomplished, practically impossible. He formally moved the adoption of the report and accounts.

Mr. A. HUBBARD seconded.

The CHAIRMAN invited discussion.

After remarks from Messrs. Elwood, Russell and Rendell,

The CHAIRMAN stated that it was originally intended that the line should only be constructed to the Elephant and Castle, but afterwards, when the extension to Stockwell was decided upon, they determined on having their terminal station there, and the electrical plant for working the locomotives also located there. Having regard to the fact that as the whole line will within a very short space of time be completed, they did not intend to go to the expense of making the Oval a temporary terminal station. He said that the fresh capital of £75,000 to which he had alluded would rank *pari passu* with the existing capital. Although he could not fix the exact date of opening, he believed it would be within a reasonable time—a few months.

The resolution was put and carried.

There being no further business to transact a vote of thanks was accorded to the Chairman, and the meeting separated.

NEW COMPANIES REGISTERED.

THE BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—Registered by Renshaws, 2, Suffolk-lane, E.C., with a capital of £750,000, in 150,000 Preference Shares of £2 and 150,000 Ordinary Shares of £3 each. Object, to acquire by transfer (for the purpose of reconstituting the Anglo-American Brush Electric Light Corporation, Limited) the undertaking and business heretofore carried on by the Anglo-American Brush Electric Light Corporation (Limited), in the United Kingdom and elsewhere, and also the letters patent and patent rights, and the lands, buildings, and other hereditaments, works and conveniences, and fixed and movable plant held, occupied and used by the Anglo-American Brush Electric Light Corporation (Limited), and stock-in-trade and effects and all other the property of the corporation ; and to undertake and satisfy the contracts and any portion of the liabilities and obligations of the corporation which may not be satisfied by the corporation or the liquidators thereof ; and with a view to such reconstitution to enter into an agreement to be made between the Anglo-American Brush Electric Light Corporation (Limited), and J. B. Braithwaite, jun., and Emile Garcke, the proposed liquidators of such corporation of the one part, and this company of the other part, and to carry the same into effect ; to continue this business, and further to acquire the undertaking and business of the Falcon Engine and Car Works (Limited), heretofore carried on by the company at Loughborough, and the stock-in-trade, effects and other property of that company, and with a view thereto to adopt an agreement dated July 12, made between the Falcon Engine and Car Works (Limited) of the one part, and Bertrand Broadhurst, as trustee for this company, of the other part, to carry the same into effect ; to carry on the businesses of electricians, mechanical engineers and manufacturers of any kind of electrical apparatus and appliances, and workers and dealers in the same. The first subscribers are :—

	Shares. Ord.	Pref.
Lord Thurlow, 33, Chesham-place, S.W.	1	1
J. S. Sellon, 78, Hatton-garden	1	1
E. Garcke, 112, Belvedere-road, Lambeth, S.E.	1	1
Col. F. G. Stewart, 16, St. James'-square, S.W.	1	1
E. Cooper, 14, George-street, Mansion House, E.C.	1	1
E. Woods, 45, Onslow-gardens, S.W.	1	1
J. Raworth, 112, Belvedere-road, Lambeth	1	1

There shall not be less than five nor more than nine directors. The first are the Right Hon. Lord Thurlow, J. S. Sellon, Colonel F. G. Stewart, E. Woods, J. B. Braithwaite, jun., the Duke of Marlborough, and A. H. Sanderson. Qualification, £500. Remuneration, £2,000, divisible. When in any year the dividend, with bonus, if any, on the Ordinary Shares shall amount to more than 10 per cent. on the capital for the time being called up, the directors shall be entitled to an additional sum equal to one-tenth of the amount of such dividend, provided that such additional sum shall not exceed in any year £10,000.

COLUMN PRINTING TELEGRAPH SYNDICATE (LIMITED).—Registered by Rollit and Sons, 12, Mark-lane, E.C., with a capital of £10,000 in £50 shares. Object, to acquire certain patents and rights in relation to printing telegraph machines, and with a view thereto to adopt an agreement, dated August 1, made between J. Moore and J. E. Wright, of the one part, and J. E. Crockett, on behalf of the Syndicate, of the other part. Most of the regulations of Table A apply.

THE FOWLER-WARING CABLES COMPANY (LIMITED).—This company, of which the capital is £200,000 in 40,000 shares of £5 each, 300 being Founders' Shares, has been formed to acquire and unite the electric cables business now carried on by John Fowler and Co., Leeds (Limited), and by Mr. Richard Waring, 85, Queen-street, London ; and to acquire and work the patents taken out for the United Kingdom by Mr. James Tatham, of Philadelphia, U.S.A., and by Mr. R. W. Eddi on, of the Steam Plough Works, Leeds, and by Mr. R. S. Waring, of Pittsburgh, U.S.A., for improvements in the manufacture and insulation of metal-covered electrical cables. Further particulars will be found on page v. of our advertisement pages.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended August 9, 1889, amounted to £5,176.

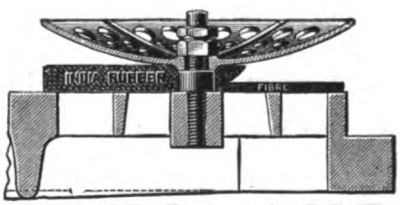
WEST COAST OF AMERICA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this company for the month ended 31st July, 1889, amounted to £5,350.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 9, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,631.

PERSONAL.—Mr. H. A. Henderson informs us that he has opened a practice at 20, York-chambers, Brazenose-street, Manchester, as consulting electrician and electrical engineer.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Aug. 14, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Aug. 14, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	3%	Anglo-American	52 53	4 14 4	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	6%	Do. Preferred	88½ 89½	4 7 7	,, ,,	89½	88⅝
2,614,820	Stock	...	Do. Deferred	17⅝ 18¼	...	February	18	17⅝
130,000	£10	10%	Brazilian Submarine	12⅝ 13¼	6 0 9	Mar., June, Oct., Dec.	13⅛	12⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	..	...
16,000	10	9%	Cuba Submarine	14½ 15	6 0 0	February and August	15 7/16	15⅛
6,000	10	10%	Do. Preference 10%	20 21	4 17 6	,, ,,	...	...
12,931	5	10%	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	...	...
6,000	5	10%	Do. Preference 10%	8½ 9⅛	5 5 3	April and October	...	...
60,710	20	3½%	Direct United States	10½ 10⅝	5 16 2	Jan., Apr., July, Oct.	10⅞	10⅜
380,000	10	11/0	Eastern	13⅜ 13⅝	4 15 5	,, ,,	13 3/16	13⅜
70,000	10	6%	Do. 6 per Cent. Preference	15½ 15⅝	3 16 2	,, ,,	15⅝	15½
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109½	109
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	108⅜	...
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13½	13 1/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	105 106	4 14 4	January and July	105	103½
179,177	10	8%	Globe Telegraph and Trust	8⅜ 8⅝	5 7 3	Jan., Apr., July, Oct.	8 1/16	8⅜
178,992	10	6%	Do. 6 per Cent. Preference	14⅞ 15	4 0 0	,, ,,	15⅛	14⅞
150,000	10	7½% for '88	Great Northern	14⅜ 15¼	4 12 4	Jan., July, and April	15¼	15
17,000	25	15%	Indo-European	40 42	6 1 6	April and October	...	...
9,000	8	5%	Reuter's	6⅞ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
30,000	10	6% for '88	West Coast of America	10 10½	5 14 3	January and July	10½	10¼
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	2 7/16	2⅜
34,563	10	12/0*	Do. 1st Preference 6%	11⅜ 12¼	...	April and October	12 1/16	12
4,669	10	†	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	6%	Western Brazilian	10⅜ 11¼	6 10 4	March & September	11⅛	11
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	⅜	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	4 8 3	...	...	...
80,000	5	25%	United	15½ 15⅝	5 12 11	June and December	15⅛	15⅜
55,000	5	3/0	United River Plate	5½ 6	...	January and July	6⅛	5⅞
			ELECTRIC LIGHT.					
23,003	5	...	Anglo-American Brush (£4 paid)	3¼ 3⅜	...	...	..	...
23,692	5	...	Do. (fully paid)	4¼ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	4⅜ 4⅝	...	...	4⅝	4 7/16
			MISCELLANEOUS.					
87,350	12	10%	Telegraph Construction and Maintenance	43 45	5 6 3	March and July	44⅜	43¼
41,600	10	10%	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19⅜	19¼

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 588.—Vol. XXIII. FRIDAY, AUGUST 23, 1889. Price Fourpence.

NOTES.

On another page will be found the last of the long-expected Board of Trade rules for the erection of overhead wires. It must be understood, however, that these rules are not of universal application, but will only be enforced in those cases to which the Board may think proper to apply them. Moreover, they are not intended to apply to Telegraph or Telephone lines, but solely to lines used for the purpose of conveying electrical energy. It will be remembered that, by the courtesy of the Board, the Committee of the Electrical Section of the Chamber of Commerce were enabled to see the original draft, and on their suggestion one or two slight modifications, chiefly in the insulation clauses, have since been made. As the rules now stand we do not think that any reasonable objection can be taken to them.

The Committee of the Paris International Electrical Congress of 1889, whose first sitting takes place to-morrow (Saturday), has issued a set of "Reports" on various subjects with which it is proposed that the Congress shall deal. These reports have been severally drawn up by various individual members of the Committee, and consequently they vary somewhat in the method of treatment and in value. The first report, by M. Pellat, is on Electrical Standards, and gives a brief but useful *resumé* of the present state of the subject, describing the existing standards, and giving the results of the latest determinations of their value. Next we have a report, by M. Potier, on the Measurement of Energy, chiefly in reference to the determination of the efficiency of dynamos. After referring to the Hopkinson and Ravenshaw methods, he describes an important improvement, due to M. Fontaine, which will be new to most of our readers. A translation of this Paper will be found in another column. The report of M. Touanne, on Telephony, is also translated in this issue. In M. Picou's report, on Transformers, he gives a *resumé* of the history of the subject which is quite unbiassed; the general treatment is, however, highly scholastic, and we find very little which would specially interest practical men. M. Hillairet's report on Dynamo Machinery is wholly historical, and even then the writer confines himself chiefly to the development of theory rather than of practice. The report concludes with some remarks on methods of distribution, the transmission of power, and the use of the dynamo in electrolysis. This is a rather disappointing performance. Next we have a report by M. Hippolyte Fontaine on Electric Lighting, in which the author claims for France the honour of having been the cradle of the industry, several permanent installations having been at work as long ago as 1874. M. Fontaine's report deals in succession with each type of lamp, and he then very briefly discusses Central Station Lighting under the three heads of Continuous-Current Stations, Battery Stations, and Alternate-Current Stations. Lastly, we have a report from M. D'Arsonval on Electro-Physiology, which is no doubt a competent and reliable summary of the present state of knowledge on this obscure subject.

After going carefully through these reports we are at a loss to understand what particular purpose they can be supposed to serve, unless they are to be taken as a basis of discussion at the meeting of the Congress. Even so, it seems to us that the distinguished authors would have done better service had they prepared Papers upon some particular question of importance. Excellent as these little essays are as a whole, they deal too much in platitudes and generalities, and are altogether too much like schoolboy themes to meet our English tastes.

The proposed scheme for establishing a Government Standardising Laboratory seems to have been imperfectly understood by certain sections of the electrical trades, and it may be hoped that the circular letter addressed to them on the subject, and printed in another column, will have the effect of extracting further information on which the Treasury may be induced to act. We are informed that delay has arisen in consequence of that Department not being satisfied with the case as presented to it by the Board of Trade. It should be the business of the Chamber of Commerce to supply the last-named Department with ample material for making good its recommendations.

The perusal of Dr. Lodge's remarkable book on Modern Views of Electricity (which we review in another column of this issue) almost inevitably leads one to give the reins to imagination and to endeavour to forecast the possibilities which the future may have in store for the electrical engineer. But resisting that temptation, we wish rather to insist upon the fact that no electrician who means to keep up with the running can afford to neglect these theoretical developments merely because at present they are theoretical only. It would seem probable, however, that the first practical service which will be rendered by modern modes of conceiving electrical phenomena will be not so much in the direction of brilliant and start-

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ling invention as in a clearer and more accurate perception of the nature of the problems to be dealt with; although this must inevitably lead, in turn, to improvements in practice, perhaps of a radical character. It is, we take it, rather more likely than not that the fact of the transfer of energy taking place wholly in the dielectric may in time become one of our habitual, and perhaps even one of our most useful, concepts. It is not so many years since FARADAY'S conception of "lines of force" was exclusively the property of a few theorists, whereas now it dominates the mode of thought and of expression of every practical worker in electro-dynamics. As to the nature and actual extent of the changes, which from our present standpoint may be dimly discerned as possibilities of the future, we shall not at present hazard even a surmise; but it is very difficult to suppose that the full recognition of these modern views—the knowledge of the facts of electrical radiation, of the electro-magnetic theory of light, of the fact that the transference of energy is confined to the dielectric, and, to mention only one thing beside, the continuous approximation towards a rational theory of the ether and its functions—are all destined to remain entirely without direct influence upon our practical work. How long a time may pass, however, before this knowledge is brought to bear is a matter which must chiefly rest with electrical engineers themselves. Meanwhile we once more counsel them not to neglect developments of theory merely because they are unable to see any immediately practical application.

WITHOUT anticipating Mr. MORDEY'S reply to Mr. ATKINSON, there is one remark which we feel it necessary to make. Mr. ATKINSON correctly points out that when running at normal speed the Mordey Alternator very closely fulfils the conditions demanded by the HOPKINSON formula for successful working in parallel. But our correspondent has overlooked the fact that the bottom is entirely knocked out of this argument by the announcement which we made in our last issue that *these alternators will run synchronously at any speed.* It is hardly necessary to add that there can only be one speed which suits Dr. HOPKINSON'S formula, at least—to allow for variations of L—at the same excitation. The circumstance mentioned by our correspondent is therefore reduced to the level of a curious coincidence. We understand that it is Mr. MORDEY'S intention shortly to invite a number of electricians to witness this experiment.

WE have received a long and interesting letter from Mr. SWINBURNE, but unfortunately it came to hand too late for insertion in the present issue.

AT the Stevens' Institute of Technology (U.S.), Messrs. SEARING and HOFFMAN have recently determined the curve representing the variation of the E.M.F. in the armature of a WESTINGHOUSE alternator. This is, we believe, the first time that this curve has been experimentally obtained for an alternator with iron in the armature. It is satisfactory to know that the actual curve differs very little indeed from a true sinusoid. The small divergence which actually exists is such as to make the curve a trifle steeper at the first rise and a little flatter at the top. The agreement is, however, sufficiently close to be almost, if not quite, surprising. The experiments were made by means of a condenser charged from a projecting point on the armature shaft, which was set to strike against a fixed stud. The point was made of somewhat flexible steel wire, and could be accurately adjusted at any required angular position. The stud had a curved surface, and was pressed outward by a weak spiral spring, so as to make the contact as brief as possible. Every precaution seems to have been taken to ensure accuracy.

A PAMPHLET has been issued by the Electric Power Storage Company containing a description of their system of distribution with accumulator sub-stations, which we commend to the attention of everyone interested in central-station work. Nearly two years ago we had the pleasure of examining the working of the automatic appliances which form a prominent feature of this system, and although we understand that improvements in detail have since been effected, we were struck both by the simplicity and the ingenuity of the devices employed. Unlike some other attempts which have been made to employ automatic methods of manipulating the batteries, nothing serious can occur even should the mechanism on occasion fail to act. The company claims that the coal consumption does not exceed 9 to 10·5lbs. per Board of Trade unit invoiced to the consumer, and that the total cost including maintenance and depreciation is only 3·26d. per unit. We shall be sincerely glad to learn in due time that the experience of the Chelsea Company bears out this sanguine estimate. Nothing could be better for the electrical industries than a conclusive demonstration of the fact that secondary batteries had become a commercial success both for central-station lighting and for traction. Such conclusive demonstration is not yet available, though we trust it will not be much longer delayed.

There is one statement made by the Electric Power Storage Company in their very reasonable desire to discredit the alternating system which admits, we think, of a very simple explanation. We quote the passage *verbatim*:—

"Reference to the proceedings of the Institution of Electrical Engineers, Volume XVIII., p. 251, will show that at Brighton, where in the Central Station the system has been altered from the old 'Brush' machines working a 'Multiple Series System' of supply, using *24lbs. of coal* per Board of Trade unit, to the more modern arrangements of the Alternating System, using Lowrie Hall Converters and Elwell-Parker alternating dynamos, *the coal consumption is 25lbs.* per Board of Trade unit. This large consumption of coal is mainly due to the comparatively large amount of energy required by the primary circuit of alternating transformers when the secondary circuits are not being used at nearly the maximum capacity, a condition of affairs which must last about 20 hours in every day."

But we believe the truth to be simply this: that whereas with the multiple-series system the day service was performed by one machine of small size, in the second case a machine, if we remember correctly, of 100 horse-power was kept running all day. It is, of course, open to further question whether either the dynamo or the transformers were in this

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case the most economical specimens of their class. We should like to see the figures from other alternating stations showing the work done in the primaries when running light during the day time.

THE notion that an increase of energy can be obtained from the secondary coil of a transformer by merely applying a continuous source of heat to the iron core is so utterly opposed to our usual ideas that one's first inclination is to dismiss the matter without a second thought. But whilst we cannot help believing that the notion rests upon some erroneous observation, yet the fact that it is being persistently asserted by Mr. ACHESON—who is held in the United States to be an accomplished electrician—seems to make it worthy of mention. Mr. ACHESON'S experiment is described more fully on another page. We hope some one of our readers will repeat it, and let us know the result.

VOLUME I. of "The Alternate Current Transformer, in Theory and Practice," by Dr. J. A. FLEMING, is now ready. This first volume is entitled, "The Induction of Electric Currents," and deals wholly with the theory, and it therefore covers ground which has never hitherto been systematically treated in a manner calculated to be of immediate use both to the student and to the practical worker in electro-dynamics. About one-half of the chapters forming the present volume have already appeared in these pages in serial form, so that our readers will be to some extent acquainted with the general style and scope of the present volume. In a few months we hope to commence the publication in the same form of selected chapters from the second volume, which will probably be entitled "The Transformer in Practice." The price of Vol. I. is 7s. 6d., post free 8s. 0d. It is published at *The Electrician* office.

A Destructive Lightning Flash.—At Marnhull in Dorsetshire 18 sheep, which had sought shelter under a tree from a storm, were recently killed by a flash of lightning.

The Fowler-Waring Cable Company.—This company has, we understand, decided to erect large works on the Thames, below London Bridge, for the manufacture of their cables.

Telegraphic Money Orders.—The Postmaster-General promises that the scheme for telegraphic money orders will be introduced by way of experiment at certain offices on Monday, 2nd September.

Poole.—The Poole Town Council have given their consent to the application for a Provisional Order by the Anglo-American Brush Corporation and by the Electric Construction and Maintenance Company.

Haslingdon.—At the last meeting of the Haslingdon Local Board it was decided that the assent of the Board should not be given to the application of the Municipal Electric Light and Power Corporation.

The Priestman Oil Engine.—The Priestman oil engine, of eight horse-power, has just been adopted at the Bwllfa and Merthyr Dare Collieries in South Wales for pumping, where it is working well and giving great satisfaction.

Postal Telegraph Revenue.—The total receipts from the Telegraph Service paid into the Exchequer from April 1st to August 17th of the present year amounted to £815,000 against £740,000 for the corresponding period of 1888.

Sale by Auction.—It will be seen by our advertisement columns that Messrs. Wheatley Kirk, Price and Goulty are instructed to sell by public auction, early next month, the business, patent rights, plant, and stock-in-trade of the Jensen Electric Bell and Signal Company.

Electric Tramcars for Birmingham.—Arrangements are satisfactorily progressing for the introduction of electric tramcars in Birmingham, on the Bristol-road route, the relaying of which is nearly completed. The cars to be used will be of the Julien type, and the work is being carried out by Elwell-Parker.

The Eiffel Tower Struck by Lightning.—During a great storm which passed over Paris on Monday evening last, a flash of lightning struck the Eiffel Tower. No damage of importance was done, although all those who were on the structure at the time felt a tremendous shock, and some of the metal work was fused.

The Electric Lighting of Penarth Dock.—At the last Board meeting of the Taff Vale Railway directors, tenders were considered for lighting Penarth Dock by electricity. It was decided to carry out the work at once, and it has been entrusted to Messrs. J. B. Saunders and Co., electrical engineers, at Cardiff.

The Georgetown Telephone Exchange.—According to the report of the Postmaster-General of British Guiana, Mr. Samuel Vyle appears to have been very energetic in getting the Georgetown Telephone Exchange into good working order, and the result is that the calls have increased by 100 per cent. in one year.

Chester.—At the quarterly meeting of the Chester Town Council last week, a recommendation of the Watch Committee was agreed to, that application be made to the Board of Trade for a Provisional Order authorising the Council to supply electricity within the city, and that a special meeting be called to discuss the question.

Keswick.—For some time past the workmen have been employed in wiring the building where the electric light is to be used. Progress is also being made by Messrs. Johnson and Phillips with the work connected with the erection of the central station at Forge, and it is still expected that the 1st October will see the light first in use in Keswick.

Fleetwood.—At a meeting of the Fleetwood Improvement Commissioners last week, it was decided that application should be made to the Board of Trade for a Provisional Order empowering the Commissioners to supply electricity for public and private purposes within the district. The Commissioners intend to oppose the application of the National Electric Supply Company.

Extension of Electrical Works.—Messrs. C. A. Parsons and Co., who are at present carrying on business at the works in Park-road, Gateshead-on-Tyne, are building extensive new manufactories on the opposite side of the River Tyne at Heaton, Newcastle, to which their business in the manufacture of all descriptions of electrical machinery will be removed in about two months time.

Launceston.—At Monday's meeting of the Town Council, a communication was received from the Devon and Cornwall Electricity Supply Company asking for the consent of the Corporation to an application to the Board of Trade for a Provisional Order authorising the supply of electricity for public and private purposes within the Urban Sanitary area. Sanction was readily granted.

Troops on the March Struck by Lightning.—Last week, as a detachment of Lancers, consisting of a corporal and four men, was returning from the manœuvres at Spandau, a flash of lightning struck a tree close to them and glanced off into the middle of the troop. All riders and horses were hurled to the ground. The corporal and his horse were killed on the spot, and one of the troopers was paralysed for some time after.

Salford.—A special meeting of the Salford Council will be held on the 20th of September to consider the notice given by the Manchester House-to-House Electricity Company, and to consider the proceedings of the General Purposes Committee and the Parliamentary Sub-Committee, with a view of applying to the Board of Trade for a Provisional Order to authorise the Corporation to supply electricity within the area of the county borough.

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The Paris Municipal Central Station.—At the last meeting of the Conseil Municipal the purchase of measuring instruments and accumulators for the testing-room of the central station was authorised, the amount to be spent not to exceed 6,700fr. Tenders were also accepted for arc lamps (65,000fr.), for steam pipes and distributing boards (15,500fr.), and one from M. Patin for transformers (30,700fr.), having a total capacity of 226 kilowatts.

The School of Electrical Engineering.—We have great pleasure in drawing attention to this admirable institute in Hanover-square, W., the autumn session of which will shortly commence. Efforts have been made to overcome the chief defects of technical schools of this class by providing it with plant and the appliances of a workshop, two-thirds of the time of every student being spent in practical work. The examiner is Mr. Gisbert Kapp.

Calcutta.—Messrs. Octavius Steel and Co., Calcutta, acting in conjunction with Messrs. Crompton and Co., have, says *Indian Engineering*, obtained sanction for a scheme for lighting a portion of Calcutta by electricity. They propose beginning with the Strand-road from Chitpore to the jetty opposite the Bank of Bengal, including the Hooghly-bridge, jetties, Port Commissioners' Buildings, and wharves along the river face. The scheme is expected to be in full work within a year.

Eastbourne.—At the last meeting of the Eastbourne Town Council, a memorial was read from the inhabitants of Kilburn-terrace, Junction-road, complaining of the nuisance caused by the smoke and smell from the Electric Light Company's works, the nuisance arising, it was said, in consequence of acids being used to clean the boilers. Several members of the Corporation said the smell was seriously injuring the town, as it was attributed by visitors to bad drains. It was decided that notice should be given the company to discontinue the nuisance.

Southampton: Important Decision.—With reference to the application of the Town Council for sanction to borrow £1,440 for purposes of electric lighting, the Local Government Board have written that they have submitted a case to the law officers of the Crown on the question whether local authorities were empowered to manufacture electricity for lighting of streets, markets and public buildings in their district without obtaining a license or Provisional Order under the Electric Lighting Acts. Their opinion was that a Provisional Order must be obtained.

Dundee University College.—The seventh session of this college commences next month, with a varied and liberal programme. Based on the lines of the Manchester Victoria University, and with a somewhat similar history, the Dundee University is one of the best of its kind in North Britain. Its Calendar for 1889-90, which we have just received, is well worth the shilling charged for it even to students who are not within reach of the college, its examination papers for last year being printed in full, together with some very useful information as to the requirements of the leading competitive examinations.

"Electrical Plant" Exhibition Supplement.—Our esteemed contemporary, *Electrical Plant*, has issued this week the first of a series of three supplements in connection with the Birmingham Exhibition. The first number contains a detailed account of the engines and boilers, the coal pit ("specially written by the wild-eyed office poet"), and the exhibits of Messrs. Crompton and Co., and of Messrs. Laing, Wharton and Down. We must congratulate our enterprising contemporary on its first supplement, which, in addition to possessing some technical value, contains a good deal of "excellent fooling" in a style it has made peculiarly its own.

The Proposed Electric Railway at Eastbourne.—The meeting convened by the Mayor to consider the question of a proposed electric railway along the sea-front, from the Wish Tower to Beachy Head, was held in the Eastbourne Town Hall on Monday evening last. Only some 20 persons attended. The Mayor having alluded to the very small attendance, proceeded to say that the Duke of Devonshire, who owned the land along which the proposed railway would pass to Beachy Head, would oppose it at every step, and many of the residents would also oppose the scheme. As no one seconded a motion in favour of the proposed line to Beachy Head, the meeting closed with votes of thanks to the Mayor.

Mr. Edison in Paris.—Mr. Edison was present at the meeting of the Académie des Sciences on Monday last. He was introduced by M. Janssen. The President, M. des Cloiseaux, welcomed the great electrician in a very cordial speech, which M. Janssen translated into English. A perfected phonograph is to be presented to the Académie des Sciences by Mr. Edison, and provided with a sufficient number of cylinders to enable it to preserve a record of the utterances of its members. On Wednesday evening Mr. Edison had a dinner given to him by the Société Générale des Téléphones. Illustrations were given of the phonograph and the telephone, the latter being placed in communication with the Opera and the Opéra Comique.

St. Thomas Charterhouse Boys' School.—We are glad to hear that the results of the recent Science and Art Examinations show that the pupils of this school have again achieved a remarkable success. Every boy—fifty-eight in number—in the upper class was presented for examination, and of these none were completely unsuccessful, a large number passed in four subjects, and several passed in six. At the City and Guilds Technical College late Matriculation Examination the whole of the candidates from this school succeeded in qualifying for admission. It is with great regret, therefore, that we learn that, owing to the lowness of the fees, the committee are put to great straits to continue this school, which is perhaps the only school in London giving technical instruction for the benefit of the upper section of the working classes.

The Telegraph on the East Coast of Africa.—The Portuguese journal *O Diario Popular* refers, in its issue of the 9th August, to the rapid development of the telegraph system in Mozambique. It states that Quillimane will shortly be in communication with Inhamissengo, Sena and Tete. The two first sections are already finished, and the third section to the interior town of Tete is expected to be completed shortly. The delay is attributed to the difficulty in obtaining workmen sufficiently skilled to undertake the work. The same journal also says that telegraphic communication between the two banks of the Zambesi by cable is about to be established. Preparations for a line between Sena and Chupanga are likewise in a forward state. Much of the success of these undertakings is due to the energy and enterprise of Senhor Alferes de Andrade, who has had the work in hand.

The Proposed Government Standardising Laboratory.—The following letter on the subject of the recent circular relating to the proposed Standardising Laboratory, has been sent out by the London Chamber of Commerce:—

"Sir: As there appears to be some misunderstanding on the subject of the recent circular sent out by this Chamber respecting the proposed Government Standardising Laboratory, at the suggestion of Mr. Crompton, chairmain of the section, I beg to call your attention to the following facts:—I have called on several of the leading instrument makers and asked them their opinion as to the value of the Kew certificates. I am informed that whereas the fee for examining thermometers, barometers and sextants is very small, that is to say averaging between the limits of 1s. and 2s. 6d., the instruments carrying these certificates command from 20 to 25 per cent. higher prices. The watch certificates are given to a comparatively small extent, but similarly their value becomes enhanced to an extent far exceeding the amount of the fees. It appears further to be admitted that the laboratories established by foreign countries at Berlin and Paris are used to a considerable extent for the certification of voltmeters and ammeters, in addition to the principal work of testing house-meters. These certificated instruments command a better price than those which are sold merely on the maker's reputation. The British trade is placed at a disadvantage on the foreign market as foreign-made instruments with such certificates are preferred to English instruments without them. I also wish to call your attention to the fact that all instruments used under the Electric Lighting Acts will have to be certified, and it is obvious that the purchaser of such instruments will prefer to buy them of a maker of such certified instruments rather than take the trouble of getting them certified himself. Should the above facts cause you to modify your views, I should be glad if you will send in another return of the probable number of instruments you are likely to send in for certification. The returns of house-meters, which have already been received from five sources only, amount to nearly 17,000 per annum."

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THE PARIS EXHIBITION.

(FROM OUR SPECIAL CORRESPONDENT).

The Exhibit of MM. Alioth et Cie.

MM. R. Alioth et Cie. have a well-arranged exhibit in the Palais des Machines, showing various types and sizes of the "Helvetia" dynamo and the methods of construction adopted by the Company, together with their newest forms of arc lamps, instruments, &c. The dynamos are arranged in two rows in descending sizes on either side of the stand; a large shunt machine and five compound ones occupy one side, and are driven off the main shafting, while a large series machine and four smaller ones are on the other side, and driven from a vertical engine in the corner of the stand

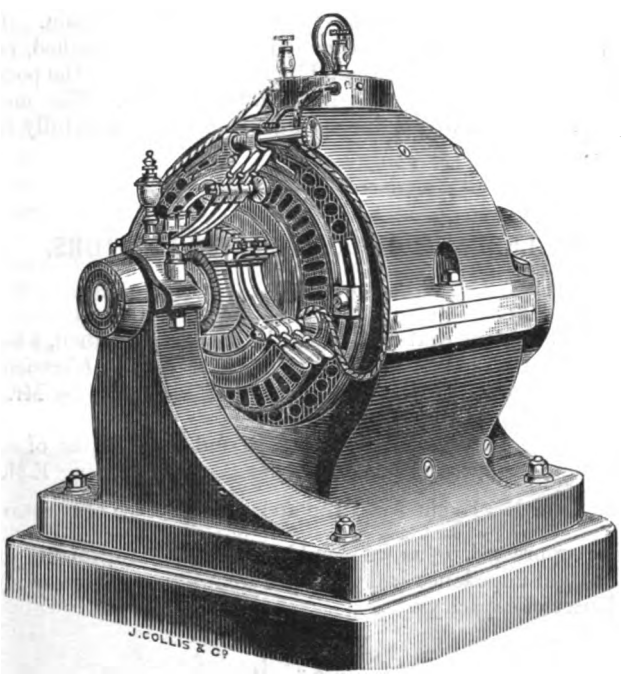

FIG. 1.—Helvetia Dynamo.

The general construction of the series and shunt machines will be understood from Fig. 1. The circular frame forms part of the magnetic circuit, and the small amount of leakage oft he lines of force is a special feature. All the machines have four poles fixed inside by large screws, the heads of which will be noticed on the outside of the frame, indicating the positions of

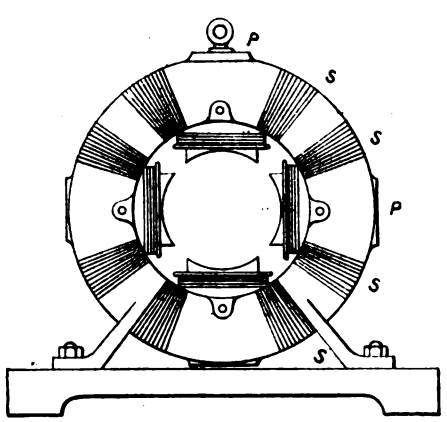

FIG. 2.—"Helvetia" Compound-wound Dynamo, showing Method of Winding the Shunt and Series Coils.

the poles. The framework usually consists of two castings, except in the case of the largest machines, where the plummer blocks and bedplate form a third casting. The same circular form is employed in the compound machines shown in Fig. 2. The field-magnet frame or body of the dynamo is in four pieces, however, the joints being in the horizontal and vertical lines passing through the centre of the circle, and the bolts concealed by the wooden panels (P, Fig. 2), to which the terminals, &c., can be fixed. The outward appearance is that of a solid ring, of oval section. The series or main coils are wound on the four pole pieces and the shunt coils, S, in eight sections round the frame. The armatures are built up of insulated rings in the usual way, except that the latter are arranged in groups of from 6 to 12, with gaps nearly $\frac{1}{8}$in. wide between them to allow of good ventilation. The coils are wound in segments first, and then fixed in position; the form of these is shown in Fig. 3. They may consist of one or more turns, according to the volts required from the machine, and are flattened and twisted at the ends, as shown at *a*, Fig. 3. Any one of the segments can be removed in case of bad insulation without unwinding the others. Slight gaps are also left between the coils as well as between the rings above mentioned, so that the air circulates right through the armature, causing excellent ventilation, and allowing in the fine wires a current density of six amperes per square millimetre (3,870 amperes per square inch) without over-heating. The bearings for the armature are carried by separate castings bolted on to the framework of the machine.

FIG 3.

The brush-holders, in the form of machine shown in Fig. 1, are fixed to a circular frame working in guides and controlled by a screw or hand wheel, so that both brushes may be moved together to shift the lead. The compound machines are fitted with the form shown in Fig. 4. A brass sleeve is clamped to the holder H, which is fixed to the framework; on to this are fastened the holder itself, B, and the rod R, which are both separate, and can be fixed relatively in any position, according to whether the brush is above or at the side of the commutator. The weight W is fixed at any point on the rod R that may be needed to counterbalance the weight of B. By raising the lever L the brush falls forward on to the commutator. In every case wire gauze folded up to the required thickness is used for the brushes instead of the usual copper strips.

In the centre of the stand are two small machines, one running as a generator and the other as a motor. This arrangement is to exhibit a motor speed-regulator which is shown in action, the generator driven by the motor being usually employed to light a projector set up in the middle of the table. This regulator consists of a set of resistance coils thrown in and out of the main circuit by a sliding contact running on a long square-threaded screw with a large cogwheel at one end and gearing with a small wheel on a spindle placed above it. This

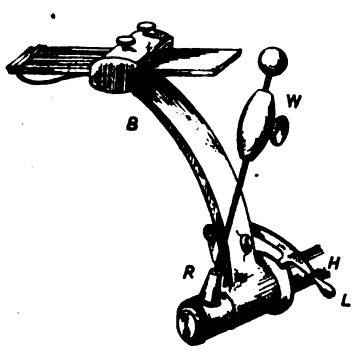

FIG. 4.—Brush-holde of the "Helvetia" Compound-wound Dynamo.

spindle carries two friction cones under the control of a governor, by the action of which they are respectively thrown into contact with two bevel wheels driven in opposite directions by a third wheel, which is in its turn driven by the motor. If the speed is too high, one of these wheels is thrown into contact with its friction cone, and the spindle is turned in one direc-

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tion, thereby throwing in resistance; if, on the other hand, the speed is too low, an opposite action takes place due to the spindle being turned in the other direction by the second friction cone. The governor itself consists of a solid ring set on angle and controlled by a spring of suitable strength.

The arc lamp made and exhibited by the company is shown in Fig. 5. There are three coils in the regulating mechanism; the upper coil on the left may be described as the break-coil, and is part of the electro-magnet which generates eddy currents in the disc D and controls the movements of the large wheel W. The lamp is differential in its action. The fine coil S, which is a shunt across the carbons, and the main coil M are placed vertically one above the other. The current entering at the terminal T_1 passes through the break-coil B, thence to the carbons, and through the main coil M to the other terminal T_2. The bobbin of the coils M and S is hollow, and the core sliding up and down inside is attached at the bottom to a link in contact with the frame L, which is centred at C. It will be noticed that there is only one pair of carbons, which are held in rack rods gearing into pinions on the same

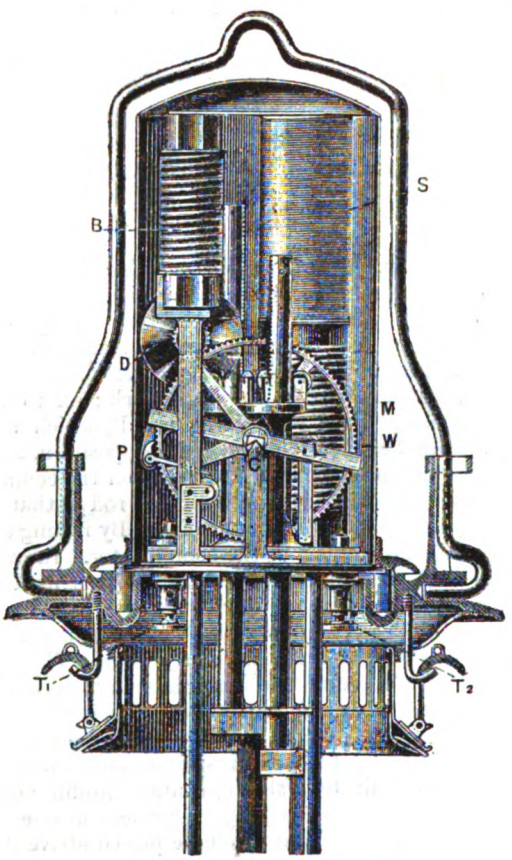

FIG. 5.—The Alioth Arc Lamp.

spindle as the large wheel W; being on opposite sides of spindle one rod rises as the other falls. When the current is started, the core that is in the centre of the two coils S and M is drawn downwards, lowering one side of the frame L, and raising the other with the catch or pawl, P, attached to it, thereby turning the wheel W, and separating the carbons. As the arc increases in resistance the shunt coil S receives more current, and the core is drawn up, thereby lowering the catch P, and allowing the carbons to approach. The upper carbon is more than double the diameter of the lower, and the lamp burns for 14 hours without renewal of carbons. The action of these lamps seems to be very regular and steady; 32 of them are arranged round one of the galleries, and joined up with four others at the stand, forming a series of 36 lamps, which are all run off one of the machines exhibited. A convenient lamp-pole is also shown, which is jointed about 4ft. from the ground in such way that the upper part can be lowered, thereby avoiding the use of cords, pulleys, &c., for lowering the lamp.

Among the instruments shown by MM. Alioth et Cie. is a coulomb meter of simple construction, though of somewhat cumbersome external appearance. It consists of a clockwork arrangement, made to run for 40 days, which drives a vertical spindle carrying a cylinder. This cylinder is partially covered by a brass hood shaped like a cone with its apex downwards, which, as it comes round, causes a wheel attached to the core of a solenoid to rotate. When the current passes through the solenoid it raises the core together with the wheel, and the more the wheel is raised the longer is it in contact with the cover of the cylinder during each revolution of the latter. The revolutions of the wheel are recorded by an arrangement of dials, and are obviously proportional to the ampere hours.

The ammeters and voltmeters show the same uniform principles of construction as those employed in the machines. The ammeters are constructed so that for a given deflection the ampere-turns are the same for all instruments. Thus, for an instrument reading up to 10 amperes there would be 100 turns, and up to 1,000 amperes one turn only on the bobbin. The core, suspended on a light arm and with pointer attached, is of flat, thin iron, somewhat resembling in shape that of the pocket ammeter now made by Messrs. Mayfield and Co. The movement is controlled by a fine spring of steel wire carefully hardened.

M. LEBLANC ON ALTERNATING MOTORS.

(*Continued from page 373.*)

(3.) M. Leblanc next deals with the condenser method, which, as has been already pointed out in these pages (*Electrician*, November 25th, 1887, p. 45), was first indicated by Mr. F. Higgins as long ago as 1878.

Consider a circuit with resistance R, and a coefficient of self-induction L supposed constant. Under an alternating E.M.F. of the form $E = E_0 \sin 2\pi \frac{t}{T}$ the apparent increase of resistance will be suppressed, or, as we should prefer to say, the inertia part of the total impedance will vanish, if we intercalate (in series) a condenser of capacity

$$K = \frac{1}{4\pi^2} \frac{T^2}{L}.$$

We shall omit the complete proof of this proposition, as it has already been given by more than one English writer. It should, however, be noticed that, strictly speaking, it holds good *only* under the assumption that L is constant, although if this be not the case the increase of apparent resistance is still diminished *pro rata*. The potential energy of such a system consists at each instant of the sum of the energy stored up by the self-induction of the circuit and of the charge of the condenser. The first is equal to $\frac{1}{2} L I^2$, and the second to $\frac{1}{2} K P^2$, where P is the difference of potential at the terminals of the condenser. This sum may be written

$$L \frac{E_0^2}{R^2} \sin^2 2\pi \frac{t}{T} + \frac{1}{4\pi^2 K} \frac{E_0^2}{R^2} T^2 \cos^2 2\pi \frac{t}{T};$$

and since by hypothesis

$$4\pi^2 K = \frac{T^2}{L},$$

the above expression reduces to

$$L \frac{E_0^2}{R^2},$$

which is constant (so far as L is constant). Hence the potential energy is constant, and the inertia part of the impedance vanishes.

The practical question is, of course, Can a condenser be made to fulfil the conditions of a practical engineering appliance, and, if so, what will be its size? Suppose we are limited to a difference of potential of 1,000 volts, and we take an air condenser with plates separated by half a millimetre, in which case there should be little danger of sparking through—then a capacity of 19·81 microfarads, say, 20 microfarads in round numbers, would be able to store 1 kilogrammetre (7·23 foot lbs.) of energy. [If, therefore,

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such a condenser was fed with an alternating current with a period of $\frac{1}{100}$ sec., work might be done at the rate of 1,446 foot lbs. per second, or 2·63 horse-power.] Applying the usual formula, we find that a total surface of 1,131 square metres would be required, or as we could make use of both sides of the metal, we may say 530 square metres. The volume occupied would be a quarter cubic metre (nine cubic feet). But M. Leblanc thinks that we need not in reality confine ourselves to the comparatively low tension of 1,000 volts, nor do we need so considerable a thickness in the di-electric. Mr. Ferranti has found that a thickness of $\frac{1}{10}$ millimetre of gutta-percha will insulate a current of 100 alternations under a difference of potential of 15,000 volts. If we multiply the potential by 15, we can divide the area of the condenser by 225, and if we reduce the thickness of the dielectric we may again diminish the area *pro rata*. It must, moreover, be recollected that the area required varies inversely as the *square* of the periodic time of the current.

The condenser method demands, therefore, high potential and rapid alternations, and it would seem impossible at present to prognosticate with any degree of certainty whether in the progress of electrical engineering we shall or shall not move in the direction here indicated. At present, we should like to see Mr. Ferranti's experiments receive some further confirmation before accepting them as an article of faith. M. Leblanc, however, seems to feel no doubt as to the future of the condenser.

Meanwhile, he makes a suggestion which may, perhaps, be of immediate value in a particular case. This is for the suppression of the double set of leads of the Tesla motor. A good many suggestions have been made for this purpose, but although the use of a condenser seems tolerably obvious, we do not remember to have met with it before. It is only necessary

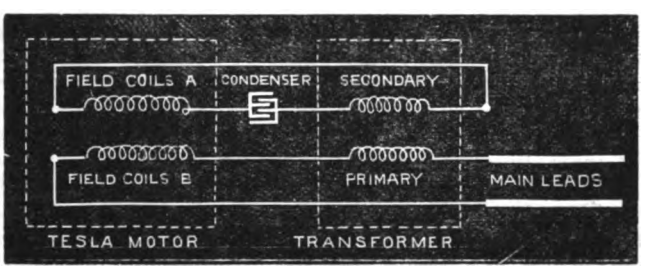

FIG. 6.

to take a transformer and equilibrate the self-induction of its secondary circuit (including in this, of course, the *external* circuit) by interposing a suitable condenser. The current in this circuit will then be displaced in phase by precisely one-quarter wave-length over that of the primary. The primary coil is placed in circuit with one set of the Tesla field coils, and the secondary with the other set, as indicated in the diagram (Fig. 6). We can, if we like, go a step further, and balance the self-induction of the primary also, so as to suppress the apparent increase of resistance of the system with respect to the generator.

M. Leblanc next embarks upon an *inquiry as to the best means to redress* an alternating current at the place of utilisation.* The author commences the inquiry with the following "*Remark*:—If the E.M.F. which acts upon a circuit is directed always in the same sense, the mean value of the current in the circuit will be independent of its coefficient of self-induction and will be equal to the mean value of the E.M.F. divided by the ohmic resistance of the circuit."

Need we say that this is a complete mistake? And although the assertion is subsequently backed up with an imposing display of mathematics, the error is not far to seek. M. Leblanc has chosen at a certain point to consider t very great, an hypothesis which does not alter the mean value of his integrals, but which limits the physical interpretation to the particular case when the periodic time is very great, which, we take it, is also the common-sense explanation. The author, however, arrives at the conclusion that "it results that a redressed current is as well suited as a continuous current to supply a motor. The inconveniences that present themselves in the employment of the currents relate not to their mode of utilisation, but to their mode of production." Having started on a false track, M. Leblanc pursues it at great length; he has a good deal more to say about the Mordey commutating motor (*The Electrician*, August 9, 1889, p. 346), of which, in principle, he highly approves, while he condemns the mode of commutation on the ground that the successive current-waves are separated by spaces of zero E.M.F., which is true enough. However, believing as we must that M. Leblanc has been led wholly astray on this point, we cannot devote further space to its consideration. We may just remark in passing that one solution to which a column of the original is devoted, requires as many wires between generator and motor as there are bars upon their commutators (!)

In concluding this section, we find one very novel suggestion which may conceivably be of some future use. The problem may be stated thus: Having an alternating-current of given period, to obtain a current of any other required period.

Take a Gramme ring, and divide the coils into three circuits, a, b, c, in such a way that every alternate coil all round the ring is in circuit c, whilst the remaining coils in each alternate *quadrant* belong to circuits a and b respectively. In fact, so far as a and b are concerned, the circuits are placed exactly as in the Tesla motor, whilst a coil of circuit, c, intervenes between every pair of coils all round. Through circuits a and b two independent alternating currents are sent which differ in phase by 90deg. again as in the Tesla motor. The coils of circuit c are connected to the bars of a Gramme commutator, and upon this, according to M. Leblanc's solution, a pair of brushes is caused to rotate. Now, whilst the brushes are at rest the coils c are the seat of an induced E.M.F. equal in period and midway in phase to that of the currents in a and b; but now, if the brushes rotate upon the commutator, it is easy to see that the period may be either diminished or increased, according to the relative velocity of the brushes as compared with that of the virtual rotation of the poles in the ring caused by the currents a and b.* M. Leblanc does not himself hint that the apparatus might be used for *increasing* as well as for decreasing the rapidity of alternation; but if the device can be put into practical shape it appears to us that the one arrangement is as likely to be of use as the other, always provided, however, the speed of commutation can be kept within limits. For experimental purposes a means of "speeding up" alternations would be very valuable.

* This is a useful word which we might as well adopt, as we have no exact equivalent in English.

[* See, however, a Note in our Editorial columns, added since this article was in print.—ED. *E.*]

REVIEWS.

Modern Views of Electricity. By OLIVER J. LODGE, D.Sc., LL.D. F.R.S. (London: Macmillan and Co. 1889.)

In this work, which is mainly a reprint of a series of articles contributed to *Nature*, Prof. Lodge has laid a lasting obligation of gratitude upon electricians. Gathering up from the researches of the most able and modern of investigators down to within two months of the date of publication, and adding to them the result of his own admirable and ingenious inquiries, he has now strung together and expounded in language as graphic as it is simple, those modern views of electricity which will assuredly in the main survive the present orthodox notions received by tradition from the electricians of an older generation. In all the older, and in much of the current literature of the science of electricity, attention is concentrated upon the so-called conductors of electricity; and all the facts are discussed, and the definitions framed, nay, even the language of the science is based upon the assumption that it is upon the conductor that the static charge accumulates, and that it is through the conductor that the so-called current flows. In the modern view of the subject, attention is concentrated not upon the conductor, but upon the medium in which it is immersed. Franklin first showed that it was the medium between the two metal plates, not the conducting metals, which really became charged. But to Faraday we owe the really great

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advance of considering the medium surrounding the conductor as the seat of those actions, both electric and magnetic, which accompany any and every movement of electricity. The dielectric capacity and magnetic permeability of media have in the last forty years been measured by many observers. Sir William Thomson introduced magnetic permeability into the theory of magnetism. Maxwell cast into mathematical mould the ideas involved in the introduction into electrical theory of the inductive capacity of the medium. Poynting and Heaviside have more recently wrought out in mathematical shape the problem how the medium can transfer electrical energy from one part of an electric system to another. Maxwell, by a daring stroke of scientific speculation, founded the electromagnetic theory of light, a theory already, by the labours of Hertz and by those of Prof. Lodge himself, amply verified and proven. But until now no one has dared to depart so far from the beaten track of orthodoxy, as to restate for popular instruction (using the word popular in its best sense), the modern science upon these new lines. Some of us have timidly suggested a point here and there; we have now to greet the man who has dared, and to welcome to his triumphs, the exponent of the modern views. Prof. Lodge, in a work of a thoroughly readable sort—though the reading is by no means all easy—and with much originality, and not a few pungent hits at friends and foes, has set forth the doctrines of electricity as a property of the medium—the ether—carrying the ideas of Faraday and Maxwell to conclusions, which, if not always final or probable, are yet logical, and of immense importance as suggestions for further lines of research.

Prof. Lodge divides his work into four parts, viz.: (1) Electricity at rest, or static electricity; (2) Electrici y in locomotion, or current electricity; (3) Electricity in rotation, or magnetism; (4) Electricity in vibration, or radiation. To the e, which constitute the body of the work, are added reprints of three lectures—(1) The relation between Electricity and Light; (2) The Ether and its functions; (3) The Discharge of a Leyden Jar. There is a brief appendix, to which some mathematical formulæ are relegated.

The most original feature of the book now be'ore us is undoubtedly the attempt to illustrate by quasi-mechanical models the ether-theory of electricity. In one set of these models a cord passing over pulleys is employed to illustrate a circuit, resistance to conduction being typified by frictional obstruction to motion, whilst elastic connections, which allow not of continuous motion, but of a yielding displacement, typify the quasi-elastic constraint offered by dielectric bodies. With this model, or rather with a set of such, are illustrated the author's views upon electrolytic conduction and on thermo-electricity, and they are most successfully employed to render clear and plain that by no means ordinarily clear or plain matter, the residual charges of a Leyden jar, and the apparent "soaking-in" of the charge arising from the heterogeneity of the dielectric. Another model, p. 173, elegantly illustrates the principle that there is a tension along, and a pressure in every direction across a magnetic line of force. This model is a centrifugal apparatus, and is introduced in connection with the theory that magnetism is electricity in rotation, each magnetic line of force being considered a vortex-core. The model would, however, equally well illustrate the tension along and pressure across an electrostatic field, concerning which there is in the modern view no such vortical action going on. Most important, however, of the quasi-mechanical models is the set for illustrating the constitution of the ether. According to Prof. Lodge's views on this latter question—views which he himself appears to regard only as tentative—the ether consists of two elements or kinds, which for want of a better knowledge may be called respectively "positive electricity" and "negative electricity," each of which elements is, as the joint ether itself is also, an incompressible fluid, otherwise called a *liquid* (pp. 12 and 65) It is, however, perfectly mobile with respect to all mechan'cal displacements, allowing solid matter to move through it freely. But with respect to all electrical forces it is quite otherwise, being exceedingly rigid toward all causes or agencies which would tend to shear away its positive elements from the negative ones. A strain in this medium produced by an electromotive force or shear, is only another name for an electric charge. A slip in this medium where its elements actually slide past one another constitutes what we ordinarily call an electric current. A medium so constructed, if it could exist, would certainly "behave in a very electrical manner" (p. 61). It is for this reason that a very large portion of the "modern views" is devoted to models carrying out this idea. In 1861, in the April number of the *Philosophical Magazine*, Maxwell published some curious speculations about a mechanical model of a magnetic medium, the parts of which were geared together by toothed wheels. To turn the mechanical difficulty that with toothed wheels directly geared, a rotation given to one part of the medium would set up in the surrounding medium a rotation of an opposite sign—whereas analogy required a similar rotation—Maxwell had introduced the well-known mechanical device of intermediate "idle-wheels," freely confessing, however, that they corresponded to no known entity. Prof. Lodge starts from Maxwell's model, but gives to the idle-wheels a new and startling significance. The medium consists of alternate sets of positive and negative wheels geared into each other so that all the positive wheels turn one way at once, and all the negative wheels turn the reverse way; and he assumes that the *reverse* rotation of the *negative* wheels shall be considered rotationally as a positive spin, so that though the individual parts may be spinning in opposite senses, the medium considered as a whole may be considered to have electrically a spin in one sense only. Concerning this notion of the medium or ether as consisting of rows or lines of wheels or cells of positive and negative electricity alternately placed or geared, we shall have something more to say presently. Having devised the medium so connected in its parts, the author goes on to explain by its means how in an insulating medium the gearing is perfect, but the wheels elastic, and how in a conducting medium the wheels are not perfectly geared by teeth, but allow of a certain amount of slip, slip being accompanied by frictional dissipation of energy. "The process of slip which we have depicted goes on in all conductors conveying a current, whether steady or variable, and in fact *is* the current" (p. 192). This ingenious method of considering the action of the medium leads to several most interesting lines of thought, which, however, cannot be followed in a brief review; suffice it to say, that in Prof. Lodge's hands it gives a good account of the induction of currents in adjacent conductors, and of the phenomena of the skin-flow of variable currents in conductors which, as the researches of Prof. Hughes have pointed out, increases their resistance. But the consequences of the new view will somewhat perplex electricians of the old school. Ohm's law they now meet with under the guise of a law of electric friction: "it asserts a connection between matter and electricity," "it asserts that when electricity flows through matter the friction between them is accurately as the first power of the velocity for all speeds" (p. 119). Further, the function of the telegraph wire or conducting line is not to conduct or convey anything, not even an impulse. "The function of the wire . . . . . is to dissipate the energy crowding into it from the medium, which else would take up a static strain and cease to transmit any more" (p. 96). "This is the function of the wire; it guides the effects transmitted through the dielectric" (p. 201). "The wire dissipates energy, it transmits none; all that enters it is lost. The dielectric alone, with its cogged-gearing, transmits energy to the distant station" (p. 202).

(To be continued.)

The Working and Management of an English Railway. By George Findlay (General Manager of the London and North-Western Railway). (London: Whittaker and Co., 1889.)

This interesting volume owes its origin to a lecture delivered last year at the School of Military Engineering at Chatham, and now expanded to its present form. We have here a clear and detailed account of one of the most gigantic, as well as one of the most successful, organisations of human labour in this or any other country. Every one who has ever thought at all upon the subject has probably recognised that the smooth and regular working of a great railway system must depend upon the existence of a system of gradu-

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ated responsibility elaborated with the greatest care and skill, and maintained inviolate in its minutest detail. We are here shown how and by what means such an organisation is carried out in practice, and we find also a most interesting account of the mechanical equipment in the departments of "permanent way" and "rolling-stock."

One chapter is devoted to the Telegraph service, which is to the actual railway line what the sensory nerves are to the muscular system. The London and North-Western Railway route now carries no less than 18,115 miles of wire, of which, however, 6,877 miles belong to the Post Office. No less than 100,323 battery cells are in use. The block signal apparatus was first introduced by Mr. E. Clark, in 1853, though it has since been simplified in working and improved in detail by Messrs. W. H. Preece, E. Spagnoletti, G. E. Fletcher, and others. It was not, however, until the year 1879 that it was found practicable to work the block telegraph through busy station yards. In that year Mr. Tyers introduced his so-called "Telltale" instrument, by which the signalman on making a forward signal receives a reminder of the number of trains in the section in the rear. In addition to this apparatus, considerable use is now made of the Telephone in the working of the more important station-yards. The regular conduct of the line has been still further facilitated by the introduction of electric signal repeaters and light indicators, by which the signalman is able to ascertain whether a signal which may be out of sight has actually obeyed the motion of the levers. This arrangement was first employed, we believe, on the Great Western Railway by Mr. Spagnoletti, but the particular form of apparatus in use on the London and North-Western Railway was designed by Mr. G. E. Fletcher.

Handbook to the London University Matriculation Examination (London: The Electrician Printing and Publishing Company.) Price 2s. 6d., post free 2s. 9d.

This handbook, which is a substantial volume of nearly 200 pages, contains the papers set in June, 1888, and January, 1889, at the London University Matriculation Examinations, each paper being immediately followed by full solutions to the questions asked. There can be no better employment for the last few weeks before an examination than a careful study of the papers which have been previously set. A large proportion of failures is, we are confident, due rather to unfamiliarity with the examiner's style of question than to the ignorance of the students. Handbooks of this description are invaluable as a supplement to the text-books usually studied by students preparing for examination.

Electric Bell Fitting. (Woodhouse and Rawson United (Limited) London.)

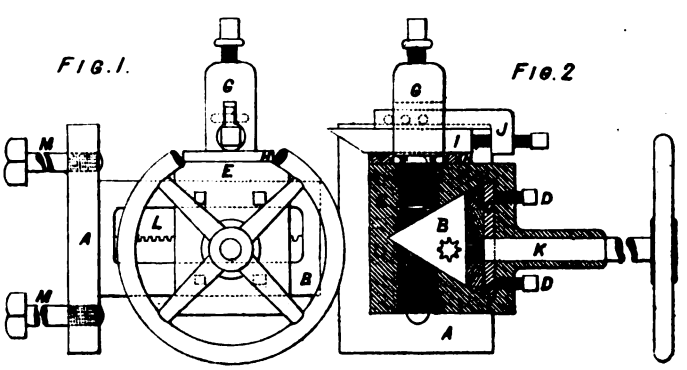
We have received from the Woodhouse and Rawson Company an unpretentious little pamphlet on the subject of Electric Bell-Fitting. The book, which is illustrated, is intended as a guide to workmen, and will admirably serve this useful purpose. Customers of the firm are supplied with the book free of charge, and we understand that a copy can be obtained on application.

A SLIDE-REST FOR COMMUTATORS.*

BY LEWIS F. LYNE.

One of the most difficult operations to be performed in connection with an electric light station is the turning up of commutators on the dynamo machines. They are sometimes put between the centre of a lathe and turned up in the ordinary manner, but this procedure, although successful so far as the turning process is concerned, has its particular objections. In the first place, the shaft is probably sprung somewhat in securing the armature, so that it will not run true. Frequently in boring the hole through the hub, hard spots will be encountered, and when the set screws are tightened to secure the armature, the shaft has to accommodate itself in a measure to the shape of the hole. Again, the wear upon the journals has a tendency to throw the shaft out, as the metal may be closer grained upon one side of the journal than upon the other, or it may have hard spots in it. The shaft may also have been turned in a lathe where the live centre did not run true; so you see there are many little things that are likely to occur in every-day practice which would prevent us from truing up commutators on lathe centres in the manner just described, and making a good job. In fact, I have seen these commutators trued up in this way run out a good thirty-second of an inch. Such a commutator when put to work, running 1,200 to 1,400 revolutions per minute, will spark at the brushes terribly, for the reason that the brushes cannot be kept in good contact with the surface of the commutator. The dynamo man will generally screw down upon the brushes, so as to get a better contact, and as a natural result tears the surface of the commutator all to pieces by abrasion of the parts in contact. I would much rather, without removing the shaft and armature from the machine, hold a piece of chalk close to the surface of the commutator and rotate it so that the chalk will touch the high spots and leave its mark. Then with a file remove the protuberances, and gradually by numerous trials work the surface down to its original condition.

This and other similar experiences led me to design and make the slide-rest shown in the accompanying engraving. The dynamos I had in charge were of the Fuller-Wood and Ball types, where to turn the commutator one has about 7in. in length, and has to work in between the end of the dynamo frame and the end of the armature. Therefore I could not use a screw to feed the tool on my slide-rest, so I adopted the design here shown in Figs. 1 and 2. I had a triangular-shaped slide made with a flange, A, at one end, 3in. wide, 6in. long, and ⅜in. thick, for the purpose of bolting or clamping this slide-rest to the end piece of the dynamos. The slide B is 6in. long and 3in. across the sides of the triangle.



This peculiar form makes a very stiff slide, and the lost motion is readily taken up by one gib, C, adjusted by four set screws, D. The rest E is made of brass, for convenience in working, as well as economy. A hole, F, was drilled and tapped with the 1in., eight threads to the inch, straight through, so that by changing the tool-post G from one side to the other the slide-rest may be in a few seconds converted either into a right or left-hand, as desired. By placing the washer H under the tool I it may set in any desired position. A gib, J, provided with holes and a pin as shown, placed on top of the tool, furnishes a ready means of adjusting and feeding the tool endwise by simply turning the set screw which presses against the butt end of the tool. The rest E is fed longitudinally by means of a small pinion cut in the end of the shaft K, gearing into the rack L. For clearness a portion of the slide B is shown, broken away to exhibit the rack, and an end view of the pinion is represented to show the eight teeth. The rack is held by two screws in a recess cut for its reception, and the shaft K is loose so that it may readily be withdrawn for convenience when putting the rest away after use. By turning the 6in. wheel the tool may be firmly and easily fed as desired. The two ⅜in. bolts M M, with iron clamps and suitable blocking, will enable the workman to attach this slide-rest to almost any style of dynamo. I use bolts of different lengths, so that we can readily attach it to any one of the fifteen dynamos placed in my charge. I never use power from a belt to drive the dynamo while I am turning off the commutator, but use instead a lathe dog with a long tail which forms a crank. This dog slips over the end of the shaft and a labourer furnishes the power to rotate the armature at the speed desired. For machines where this dog cannot be used, I have a crank that can readily be clamped to the rim of any pulley, and so accomplish the desired end. In reference to the rapid operation of this tool, I may say that I have often turned up commutators that were badly worn, in from ten to twelve minutes.

* From *Power and Steam* (U.S.).

Gallant Conduct.—The Royal Humane Society's Bronze Medal has been awarded to Mr. W. Croker, telegraphist at Waterford, for saving life from drowning.

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Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

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Subscriptions are received by this Company for all Continental and American Electrical Journals. Subscription Rates on application to "THE PUBLISHER." *Remittance must accompany order* IN ALL CASES.

RAIDING THE LOCAL AUTHORITIES.

The list of Provisional Orders, of which notices have been served upon Local Authorities, published in our last week's issue, appears to have created some surprise, both in respect to the number of applications and the manner in which they are distributed. The raid on the provinces has been carried on with much vigour down to the very last moment at which notices could be served so as to be in time for the Parliamentary Session of 1890. Our readers have now had time to study the list, and, aided by the epitome furnished in our leading columns, they are in possession of material for forming an opinion on the general situation. In attempting to estimate its true significance, however, it is very necessary to remember that the mere serving of a notice upon the Local Authority is a step which anybody may take at the expenditure of a postage stamp, and which does not necessarily entail any further responsibility. As a matter of fact, the Local Authority may never hear further on the subject. Upon the whole, we are inclined to think it a pity that the Act, or the Board of Trade under the powers conferred by it, does not insist on a deposit of substantial caution-money at this stage as a guarantee

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of good faith; for, as we have already hinted, it is impossible, on closely examining the list, to avoid the suspicion that many of them are mere fishing or speculative notices which will never be proceeded with. If the credit of the electric light at this critical juncture were not at stake we should be content to see these will-o'-the-wisps compelled to try their best and worst at their own expense. But under present circumstances we trust that the Board of Trade will do for the provinces what it has done for the Metropolis, and by subjecting the applicants to a close investigation of their financial and technical resources, effectually extinguish the pretenders. And this course, we contend, ought to be followed whether there are competing applicants or not; for no doubt the idea which has prompted the wholesale scattering of notices is that legitimate applicants would be to some extent kept off by the expense and inconvenience attending a formal Board of Trade inquiry where competing claims have to be contested at every point. If it were understood that a local inquiry would take place in any case, it would do much to induce many of the companies to disappear from the scene altogether.

One of the most striking features of this extraordinary list of notices is the overwhelming preponderance of a single company and its offshoots, who down to the present date have taken preliminary possession of by far the greatest and most important areas outside the metropolis. It would, of course, be a little rash to suppose that there is any real intention to proceed in many of these cases to which we allude, yet the appropriation of about one-half of the whole number of notices by one company looks like rushing the business with the object of frightening off competitors. We do not pretend that these proceedings afford any legitimate ground for complaint against the companies in question—from a purely commercial standpoint their tactics are probably very sound, they get an excellent advertisement in all the towns in question, and they will be able by-and-bye to select for further operations those localities which may appear most worthy of attention. But we cannot help deprecating the manœuvre in what we believe to be the best interests of the industry. We want, if possible, to have done with the era of abortive efforts and Stock Exchange manipulation, and to settle down to good, solid work. But apparently this is still as much as ever a Utopian dream.

But perhaps the hardest case of all is that of the local authorities themselves, who, pelted with these missiles, have to make up their minds to either tamely surrender, or promptly find a stick to lay on their own backs. Before the end of November they must give notice of their own intention to supply the electric light, which they do not like to do, or allow somebody else to step in and do it, which they like still less. We frankly admit that in many instances neither of these alternatives can be kindly entertained by the townspeople concerned. We have always held the opinion that the electric light business would have fared better to be left alone to grow naturally without artificial restrictions on the one hand or compulsory powers on the other—although under the circumstances this was perhaps impossible. Accepting, however, the law as it stands, the difficulty may perhaps be got over by taking counsel with the best known electric lighting supply or manufacturing companies, and putting forth all their strength against the intrusion of speculators on whom the towns can place no reliance. Those towns which finally decide to supply their own electricity will have no difficulty in finding the necessary plant and professional help by paying for them. Where private venture is preferred, the local authorities ought to give their strong support to the particular company or firm they have confidence in. One or other of these courses they ought to adopt, and that speedily. Our object in offering these remarks is to help them to make their choice wisely.

In making this choice the Local Authorities have clearly to understand they are not free to exclude outside Undertakers by a merely passive resistance. Specific and reasonable cause of objection must be shown to any proposed Provisional Order—general objections to the introduction of electric lighting weighing but little with the Board where there is reasonable ground for believing that the inhabitants are anxious to be placed in a position to obtain its advantages. The most effective obstacle they could interpose would be, of course, an application for a Provisional Order by the Local Authorities themselves. Here the temptation will arise to take that course without any serious intention of following it up. But this again will not serve their turn, for if they obtain the Order they will be bound, like ordinary Undertakers, to supply electricity on demand within a period determined by the Board of Trade in granting the Order. In the recent discussion at Manchester, it seemed to be thought that "there was no hurry to decide anything as they had three years to look about them." They will soon find out that there is something more to be done in that time than looking about; and meanwhile they have to come to a decision in little more than three months.

THE CHELSEA ELECTRICITY SUPPLY COMPANY'S INSTALLATION.*

The following description of a typical installation of the Electrical Power Storage Company's system of distribution, such as the one now working at Chelsea, which has been carried out by the Anglo-American Brush Electric Light Corporation (Limited), the Callender's Bitumen Telegraph and Waterproof Company (Limited), and the Electrical Power Storage Company (Limited), may probably give the best idea of the working of the system. The dynamo plant consists of a number of dynamo machines, each of 500 volts, and capable of giving a current of 75 amperes, placed in series with each other until the limit of electromotive force in the charging circuit is reached. These dynamo machines are driven, in the case of the Chelsea Company's installation, from separate Willan's, or other high-speed engines, coupled direct. The magnetic fields of the dynamo machines are excited by means of a separate compound-wound dynamo machine and engine, which is solely devoted to this purpose and the lighting of the engine-room. At the generating station there is also a storage station, and the charging current is applied to this first, or No. 1, storage station, in series with No. 2 and No. 3 storage stations, in suitable localities in the district.

The storage battery in each of the Chelsea Electricity Supply Company's sub-stations consists at present of 8 sets of 54 L-31 E.P.S. cells, in glass boxes. These are of the latest and most approved form, generally known as "1888" type, in which the plates are supported clear of the bottom of the cell, or containing vessel, by means of a footlike prolongation of the bottom corners of the spongy lead plates, and the peroxide plates are carried on an insulated saddle bar forming a metal connection along the edges of the spongy lead plates.

The cells are carried in varnished wood trays on sawdust or felt, the trays being supported on oil insulators which are carried by wood beams resting in sockets of strong cast-iron standards which carry from 3 to 5 tiers of cells according to the available height of accumulator room. Along the top of these iron standards a pair of rails is laid and an overhead gear of simple and convenient construction enables the attendant to put a cell into place in the circuit, or to remove one if desired, in a few minutes.

The floor space required per 1,000 lamps of 30 watts is 225 square feet, equal to 1·125 square feet per cell and 0·225 square feet per 30 watt lamp when the accumulator room in the storage station is 9 feet in height.

The batteries are charged in series of four sets of 54 cells in each station. The principle of the system is that it is impossible for the supply circuit to be interrupted, that is to say, for both halves of the whole battery, or more than four sets of 54 cells in each sub-station, to be charging at any one time, the other half or four sets in each station being applied in parallel to the supply circuit. Considerable misconception has arisen respecting this point, and it

* Extracted from a Pamphlet issued by the Electrical Power Storage Company.

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must be understood that the whole battery in each sub-station, which is capable of supplying 2,000 lamps of 30 watts, is charged in *two distinct halves*, and there are *not two whole* batteries. The charging process will usually commence at about 4 a.m., and the operation will be as follows :—

After getting up steam in the usual manner, the engineer in charge completes an electric circuit by a switch at the generating station, which has the effect of placing the first half battery in each accumulator or sub-station on to the circuit of charge, and all the accumulator stations in series. A voltmeter at the generating station applied to the charging leads then indicates the electromotive force of the batteries thus placed on the charging line, and it is only necessary to run the charging dynamos to give the same electromotive force on open circuit, when they may be switched into circuit with the batteries, the speed of the dynamo machines, or the strength of the magnetic fields being then gradually increased until the proper charging current is reached.

Assuming that the first half-battery in each sub-station may take, say, six hours to charge sufficiently to make up for the consumption of the previous day, it will then be charged by 10 a.m. The charge being complete, evolution of gas from the spongy lead plates takes place, and the gas which is given off from the end plate of one cell (technically known as the "Master" cell) is collected in a chamber fixed above the plate, and passed on by a tube connecting the said chamber to a gasometer, which is fitted with a relief valve controlled by the current in the charging circuit. The gas accordingly fills the gasometer and causes its movable portion to rise, and thus actuate the switching gear attached to the transposing switches, causing No. 1 half of the battery to be removed from the charging circuit to the circuit of supply, while the continuity of the charging circuit is maintained by switching a resistance into parallel with the half-battery as it is being switched from the charging circuit to the circuit of supply, and keeping the resistance in this position for about half a minute, while the second half-battery is being removed from the circuit of supply to that of charge. This latter operation takes place owing to the relief valve of the gasometer being opened by the cessation of the charging current in the charging circuit of the batteries, thus allowing the collected gas to escape, and bringing the movable portion of the gasometer with its attached switching arrangements into the original position whereby it places the batteries into the charging circuit. The charging process is thus continued, but only as regards the second half of the battery in the storage stations, and when at, say, 4 p.m., the second half-battery has been filled, gas is again evolved from the spongy lead plates, and by a repetition of the previous action of the gasometer, the battery is removed from the charging circuit and placed into parallel on the discharge or supply circuit with the first half of the battery which had been charged in the early portion of the day.

Should it be found necessary during the darker months of the year to augment the capacity of the sub or accumulator stations during the two or three hours of maximum lighting in the evening, the charging current from the dynamos may then be connected to a continuous-current transformer in each subsidiary station. The motor coils of this transformer, on being supplied with a high tension current of *constant quantity*, similar in fact to the usual charging current and generated by the usual charging dynamo machines, causes the generator coils to yield a low tension current equal in electromotive force to that existing on the supply circuit at the battery terminals, and also of *constant quantity, whatever be the conditions of resistance of the supply circuit.* By working the charging dynamo machines at their normal capacity, and using the current as above described for actuating continuous transformers, the capacity of each storage station to give supply of electricity to consumers is increased by 50 per cent., and in consequence a large increase of earning power, involving a very small additional capital expenditure, is added to the capacity of the plant as a whole.

It will be understood, therefore, that generating plant and dynamos indicating *one-half of the maximum capacity of the system* is sufficiently ample (this amount including a due proportion of spares, which proportion is, however, less than is possible on any other arrangement, in consequence of the long time at the disposal of the engineers in charge for making repairs), the storage capacity being always sufficient for two-thirds of the maximum demand.

In considering the respective advantages of various systems, the question of space and dimensions of generating station should receive due prominence. It is comparatively easy to obtain premises, &c., to accommodate generating plant for, say, 15,000 lights, and this would supply on the E.P.S. system 30,000 lights, whereas on systems without storage a proper provision of spares or reserves would entail space and machinery for 40,000 to 45,000 lights, and on parallel systems using only a small proportion of storage as reserve, machinery capable of working the whole 30,000 lights would be needed.

The regulation of pressure or electromotive force in the distributing mains is attained by means of the introduction into the discharge circuit of counter electromotive force cells controlled as follows :—A solenoid core is suspended against the action of gravity by the magnetic field caused by placing the coil in parallel with the distributing mains. Any rise or fall in the electromotive force at the mains is communicated to the core, and contacts are made by the movements of this core which actuate simple switches for inserting or removing from the supply circuit counter electromotive force cells giving a difference of potential of from 2 to 2½ volts each. A mean regulation with a variation of not more than 1½ volts on either side of datum is thereby maintained, so that in a 100-volt circuit the lowest possible potential on the mains will be 98½ volts, and the highest possible will be 101½, the average being very nearly the normal figure of 100 volts.

The apparatus for effecting the various transpositions of the secondary batteries and for maintaining the pressure constant is entirely automatic, the movable portions being worked by the energy which would otherwise be wasted in the counter electromotive force cells, which are used for regulating the pressure on the supply mains ; the result is that all the actuating portions of the apparatus require current at an electromotive force of only 4 or 5 volts, and it is therefore cheap to manufacture and exceedingly reliable. The operations of breaking and making circuit are performed without sparking, and the loss of energy in the apparatus is so small as to be quite unimportant. Attention is directed to the fact that the possible loss of automaticity of the apparatus will not do any damage to the plant nor cause other inconvenience than the presence of an attendant while repair is being made.

PARIS INTERNATIONAL ELECTRICAL CONGRESS.

The following programme has been issued by the Congrès International des Électriciens :—

SATURDAY, August 24th.

10 a.m. Inaugural Séance at the Salle des Conférences du Trocadéro. Nomination of the Bureau. Formation of Sections. Division of labours.

8:30 p.m. Electric Undulation Experiments by M. EGOROFF at the Société d'Encouragement, 44, Rue de Rennes, Place Saint-Germain des Prés.

SUNDAY, August 25th.

8 a.m. Ascent to the third story of the Eiffel Tower. Visit to the instruments of observation. [N.B.—Members of the Congress who enrol themselves at the inaugural Séance will be taken up half-price.]

MONDAY, August 26th.

Meetings of Sections, and visits to the Exhibition, organised by each section.

TUESDAY, August 27th.

Meetings of Sections in the morning.

2 p.m. Visit to the Laboratoire Central d'Électricité, and to the works of the Société Générale des Téléphones and of MM. Sautter et Lemonnier.

WEDNESDAY, August 28th.

Meetings of Sections and visits to the Exhibition.

THURSDAY, August 29th.

2 p.m. Visits to the Palais Royal and Opera Central Stations.

FRIDAY, August 30th.

Meetings of Sections and visits to the Exhibition.

SATURDAY, August 31st.

General Séance and close of the Congress.

7:30 p.m. Banquet at the Hôtel Continental, given by the French members of the Congress to the Foreign members.

(i.) During the Congress, visits—the dates of which have not yet been fixed—will be made to the central lighting stations and private installations at the Exhibition.

(ii.) There will be Special Séances for the members of the Congress to hear the Edison phonograph and telephonic auditions in connection with the Opera, and to witness the electro-dynamic and electric welding experiments of Professor ELIHU THOMSON.

(iii.) Any information may be obtained at the Société Internationale des Électriciens, 44, Rue de Rennes.

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From the Reports presented to the Congress we have selected the following :—

The Measurement of Energy.

REPORT BY M. A. POTIER.

At the time when dynamo-electric machines first came into commercial use, the question of efficiency was of secondary and theoretical importance. An efficiency equal to that of a sufficiently powerful battery was all that was expected of them, and their general superiority was so obvious that no one dreamt of taking the trouble to take exact measurements. In a large number of installations, even in these days, owing to the power absorbed by the dynamos being but a small fraction of the total power used, the excessive absorption of power by the electric lighting machines is masked, and the only thing required of the dynamo is regular working. Now that the applications of electricity have become more numerous, that we are attempting long distance distribution of energy, and that an active competition exists between different types of machines, the efficiency of a dynamo is an important commercial factor. It seems useful to exactly define what we mean by efficiency, and to agree as to the methods of determining it.

We define the efficiency of a dynamo, whether motor or generator, as the ratio of the useful energy to the energy expended ; electrical energy being measured at the terminals of the machine, whilst the work, in order to avoid the uncertainty of transmission arrangements, should be measured on the shaft of the machine itself. The efficiency of a motor can generally be determined with exactness, except at high speeds. Brake indications are very accurate if the requisite and well-known precautions are taken, while electrical measurements can be made with even greater accuracy. The efficiency of a generator is also easy to determine when an appropriate transmission dynamometer is available, but unfortunately these complicated and costly instruments cannot be improvised like brakes, and their indications may be falsified if the speed exceeds a certain amount, so that each apparatus is only useful between rather narrow limits. Dynamometers in which the difference of tension of the two halves of a belt is measured seem, moreover, by no means over-accurate. It has also been sought to determine the efficiencies of generators without having recourse to these dynamometers, especially in the case of large machines. We can also proceed by a method of substitution, and, after having obtained from an indicator diagram the work done on the piston at different speeds, and the electric horse-power of the dynamo, substitute a brake-pulley for the dynamo. In this way, if we admit that the efficiency of the steam-engine and of the transmission gear has remained the same under practically the same conditions of speed and power, we have the necessary data for the calculation of the efficiency of the dynamo.

In the case of two machines, the efficiency can be determined by the method employed by the Drs. Hopkinson. The two dynamos are mounted on the same spindle, and united electrically in opposition, so that one works as a generator and the other as a motor. A dynamometer, which may be a small one, measures the power transmitted to the system, power which is entirely absorbed by the passive resistances, Foucault currents, and in heating the coils of the machines. This method has been modified by Mr. Ravenshaw, who suppresses the dynamometer and introduces a third dynamo, driven by the same engine, into the circuit of the two first, the power which this last machine furnishes being determined electrically. If we call this third dynamo C, and the two other dynamos A and B, the ratio of the differences of potential at the terminals of A and B gives the efficiency of the system A B. Let R_3 be this efficiency. We can determine by the simple comparison of two electrical measurements the efficiency R_2 of the system A C, and finally the efficiency R_1 of the system B C. If we call r_1, r_2, r_3 the individual efficiencies of the machines, and if we suppose that they are the same in all three experiments, then $r_1^2 = \frac{R_2 R_3}{R_1}$. It seems doubtful if this method can lead to accurate results, for the efficiency of a machine varies with the intensity of the current which traverses it and with the speed, and it does not seem possible to run the machines in the three experiments at their normal load and velocity.

M. Fontaine has used a simpler method based also on the employment of three machines. Machine A is mounted on the same shaft as machine B, which runs as a motor, the current being furnished by a third machine, C. The machine A is outside the circuit B C, and is closed on a circuit, whose resistance is regulated so that the current in it is the same as that in B C. The ratio of the differences of potential at the terminals of A and B gives the efficiency of the system A B. When the two machines are identical M. Fontaine admits that the efficiency of each is the square root of the total efficiency, which amounts to saying, as is done in the case of the methods derived from that of Hopkinson, that the efficiency is the same whether the machine is a generator or a motor. Upon this hypothesis it would be easy, by making three experiments, to determine the individual efficiency of each machine. These two methods (those of Ravenshaw and Fontaine) seem very suitable for the rapid comparison of the efficiencies of machines of the same type ; but the moment we admit the equality of the efficiencies, the use of transmission dynamometers becomes unnecessary, and the brake test should suffice when it is a question of determining the efficiency of a single machine. But a reservation is necessary ; it is not permissible to say that the efficiency is the same for two identical machines working under the aforesaid conditions. The efficiency of the two-machine system may be *nil*, for instance, without that of the motor being *nil*. It seems more rational to say that, for equal magnetic fields and armature currents, the losses due to Foucault currents and friction of all sorts are the same for equal speeds. In M. Fontaine's method, for instance, if $\frac{100-x}{200}$ is the efficiency of the system B A, composed of two identical machines, the efficiency of B should be $\frac{200-x}{100}$, and that of the generator A $\frac{200-2x}{200-x}$. Following out the same idea, if $\frac{100-x}{100}$ is the efficiency of a motor, its efficiency as a generator, under the same conditions, would be $\frac{100-2x}{100-x}$.

If careful experiments confirmed these views, a series of brake tests—tests which engineers consider to be capable of being made very accurate—would be sufficient to determine the efficiency of a generator under the various conditions of working. It would be interesting to know between what limits we may consider the efficiencies as equal ; or, in other words, the losses of the same machine working as a motor or as a generator as equal.

In shops where several machines are available it would always be possible to determine the efficiency of a generator without employing a transmission dynamometer. My experience has shown me that up to 50 horse-power, at any rate, a motor is an excellent dynamometer. If we measure on the brake the power furnished by the machine, we shall always find within the limit of error the same efficiency when the machine works under the same conditions of speed and load, although the E.M.F. may slightly vary, the machine, of course, running in its normal condition as regards lubrication. We can therefore test a motor at a series of speeds, form a table corresponding to a series of current intensities, and this done with all possible care, the test of the generator would be made by merely coupling it to the motor shaft and comparing the number of watts furnished and absorbed by the two machines. It is evident that this method would be equally applicable to the measurement of the efficiency of an alternator. It has the decided advantage that the forces applied to the machine to be tested are reduced to a simple couple. By the suppression of belts we eliminate an error, which it is impossible to determine, arising from the variable tension of the belt, an error which the use of dynamometers does not efface.

If, on the occasion of the Exhibition, competent men were enabled to exchange views on this question of efficiency and succeeded in laying down a few uniform rules, it would be a great advantage to dynamo designers and those who use them.

Telephony.

REPORT BY M. DE LA TORRANNE.

Telephony, by rare good fortune, has in less than ten years extended over the whole world, and an instrument regarded at first as a scientific toy, has become the foundation of an industry which extends its domain from the village to the largest cities. But the very rapidity of its development has brought with it a certain element of danger. No sooner is one arrangement adopted than another more ingenious and more practical follows, and we have seen a company solicitous for its good name positively sweep away a system which it had only just brought into use, and proceed to reconstruct the whole from the commencement. Now, although we can never hope to get wholly beyond the necessity for improvement, yet such wholesale changes might often be avoided if there were more frequent opportunities for the interchange of experience amongst practical men. Questions concerning lines, apparatus, exchanges, and tariffs present themselves under a hundred different aspects, and their consideration will have great interest amongst those who are competent to discuss them in the light of experience.

For the lines, universal opinion seems to point to the use of copper and its alloys. But we have yet much to learn as to the conditions under which it is advantageous to use either of the bronzes, or hard or soft copper. The latter, by reason of its low tensile strength, seems reserved for cables, but the former varieties have probably scarcely yet arrived at their definitive form. Many types have been proposed ; what are their precise specifications, and what their advantages and disadvantages ? At what resistances, at what capacity do we stop short in practice ? How many wires is it convenient to put in a single cable ? What modifications is it desirable to make in constructing a cable, according to whether it is to be used for single or metallic circuits ? Upon this point of metallic circuits, how are the overhead lines best arranged ? Is it not possible to use a common return wire for such circuits ? In that case how should the wires be run upon the poles ? These are some of the questions which may be discussed.

Telephonic apparatus does not afford us a very wide field for remark. The multiplicity of models of microphones, telephones and signalling apparatus, due to the fertile imaginations of the inventor, renders it difficult to classify them. Often the differences are of no commercial importance. . . . . The great majority of the auxiliary apparatus used in telephony are merely adaptations or modifications, more or less happy, of well-known devices used long ago in telegraphy. . . . . .

As regards the central stations or exchanges there are many points which merit special attention. As to switchboards, what facilities ought they above all to present ? What is the smallest number of subscribers which renders the multiple system indispensable ? Everything should be sacrificed to secure the rapid and correct working of the system. . . .

But the most perfect appliances will be thrown away unless we have a thoroughly good system of regulation and supervision over the *employés*. It will then be interesting to compare the various regulations in vogue in different places. Another class of questions to be considered is such as this : Whether a subscriber who asks for a connection which cannot at once be made, should be left to call again or should have the connection made for him when the wire is free.

Another matter intimately affecting the prosperity of the business is that of tariffs. It is very difficult to lay down any definite principle or to find a common standard by which the tariffs of different localities may be compared. We want more statistics. We cannot learn much from the mere ratio of the number of subscribers to the number of inhabitants unless we have full information as to the commercial and social conditions of the town.

These are only a few of the many questions which might be raised, but it is believed that they will well repay examination.

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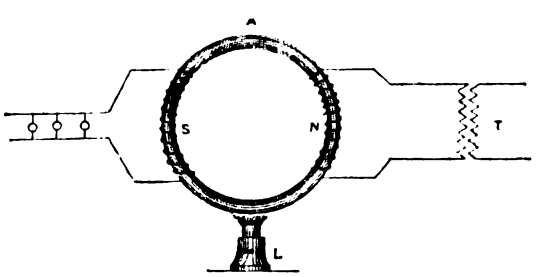
ACHESON'S CALELECTRIC GENERATOR.

From time to time during the last twelve months we have noticed in the American journals reports of the most startling character relating to the discoveries of Mr. Acheson, of Pittsburgh, in a field which he has, so far, made wholly his own, and which he terms "calelectric generation." Up to the present time, however, we have been unable to come across any sufficiently clear or exact description of what Mr. Acheson has actually accomplished—or believes himself to have accomplished—to be worth reprinting. But at length we have an account in the *Electrical World* (New York) which leaves us in no further doubt on the latter score, and accordingly we print it below. In view of the demand which this article makes upon the faith of the English reader, it may be well to add that Mr. Acheson is held in no small esteem in electrical circles in the States, and although his "explanation" of the phenomenon is not quite up to European standards, yet his good faith is, we believe, beyond question. The *Electrical World* article is as follows:—

The work of Mr. Edward G. Acheson, of Pittsburgh, on the conversion of heat directly into magnetism and electricity is already known. Briefly stated, the method devised by Mr. Acheson consisted in causing heat-lines to traverse an electric conductor and produce a magnetic whirl, cutting the heat-lines and thereby converting the heat energy into electric energy.

Since commencing this work, Mr. Acheson has elaborated various other methods analogous to the first, one of which is shown diagramatically in the accompanying figure. The arrangement consists of an alternating-



current generator, with a converter so arranged that the iron core may be put under the influence of heat, a thermometer being included in the secondary coil of the converter as a current and heat indicator.

With an apparatus arranged as above indicated and having a given current at T, with the source of heat removed, there is registered on the thermometer a certain value representing the electric energy traversing the coil S and its circuit. But when the source of the heat L is placed in proper position to cause the heat-currents therefrom to impinge upon the mass of magnetic material, with the source of energy at T the same, it is found that the thermometer shows an increased value for the electric energy in the coil S.

Mr. Acheson explains this action on the assumption that if heat can be converted directly into electricity, it should also be possible to produce magnetism from heat energy, and if this is the case the application of the heat energy to the magnetic material will result in an increased magnetic state of the magnetic mass, which will react upon the coil of wire surrounding the mass, and produce therein an electric current, which will represent a part of the energy of the heat. While Mr. Acheson has not yet been able to clearly demonstrate this fact, he has demonstrated fully that the application of heat in the manner described does produce a material increase in the current flowing through the coil S and its connections.

NATIONAL ELECTRIC LIGHT ASSOCIATION, U.S.

Storage Battery Traction.*

BY J. BRACKEN.

It has been customary for speakers on storage batteries to begin their discourse by apologising for their subject. That day has gone by. The storage battery has no longer any apologies to make.

My purpose at first was to give a detailed account of the progress of storage battery traction by going back to 1881, when the first storage battery car was run and following up the history of improvements from that time to the present. But I have found it impossible to get full and reliable data as to the work accomplished in Paris, in England, or in this country. I wrote to almost all the companies and individuals who have been engaged or are now engaged in storage battery traction to send me full accounts of their experiments and work; but I regret to say that only one responded to my request, and that was Mr. A. H. Bauer, who gave me a very interesting account of his experiments with his storage battery car in Baltimore, in 1885-86. I am therefore compelled to confine my remarks to my own observation of storage battery traction. I will not weary you with threadbare information. I once heard a judge tell a loquacious lawyer that he must assume the Court knew *some* law. I will assume that you have a pretty general acquaintance with the storage battery in lighting and in traction; but there may be some features, chiefly commercial, that have not come under your observation. My observations cover a period of over three years, during which time the company with which I am associated has directed its talents and energy to the development of storage battery traction. You all, no doubt, appreciate the difficulty of the task—not alone difficulties inherent in the system itself, but difficulties arising from the scepticism and lack of sympathy, I regret to say, of a very large majority of the electric community. We all know how much scepticism on the part of street railway men has had to be overcome in electric traction of every kind. It has taken a great deal of hard work—of missionary work—on the part of electrical engineers and inventors to bring about present results. But this is not to be wondered at; for there is nothing harder to accomplish than to supersede an old and well-established system. The horse car had plodded along and gathered strength and influence just as it had gathered fares. That influence was wide spread and almost all-pervading, for there is hardly a town on this great Continent that has not its horse-car line. The horse-car system has been spreading for about fifty years, and when it came to be in full and undisputed possession of the field, can it be wondered that those men who had the hardihood to attempt to supersede it should be regarded with more or less suspicion—should be looked upon as pretenders—especially when you consider that the method which they propose to employ was electricity; that dark and mysterious science as many people, even now, regard it.

Now, the first experiments made with electric cars were calculated to increase this suspicion and to throw disfavour on electric traction; for it is a characteristic of inventors to be so far carried away by their enthusiasm as to commit great indiscretions in carrying on experiments in public, which really should be conducted in private. It was on this account that the early experiments of Daft, in 1883, and of other well-known electric engineers in succeeding years, while they created wonder, did not beget confidence. I may say without any invidiousness that two years ago there was not a single electric car run in this country that proved anything more than possibilities.

There were probably two dozen cars being run at that time by the overhead wire system, but so unsatisfactorily that people who went to see them came away shaking their heads with distrust. Now, all this distrust has disappeared and electric traction has grown so fast, that to-day there are no less than one hundred street car lines in this country that are either running their cars by electricity, or are in the course of introducing the system. Electric traction has beyond all doubt come to stay; as the French say, it has arrived. But the large cities are threatened with the cable. The storage battery proposes, however, to challenge its supremacy. . . . .

When the storage battery first became known in a practical and commercial form by the experiments of Plate in 1859, scientists foresaw for it a great future, and when corporations were formed later on to exploit and introduce the storage battery, the people of Europe, influenced by what might have been considered the extravagant praises of Sir William Thomson and other well-known scientists, put an enormous amount of capital into storage battery enterprises. Almost all of those enterprises, however, proved to be commercial failures, first because the exploiters were ahead of their time, and secondly because the public were led to expect more than the storage battery, in its then crude form, would do.

There probably have been few things more difficult to accomplish than to bring the storage battery to its present stage of commercial value. Notwithstanding all that had been written about its nature and characteristics, its treatment both in its manufacture and use has, until very recently, been purely empirical. That stage, fortunately, has been passed; so that, with intelligent care, the storage battery to-day is not only a valuable adjunct in lighting, but is becoming a very prominent factor in traction.

The advantages of storage battery traction, assuming that it is practical and economical, are too obvious for me to occupy your time in recounting.

The obstacles in the way of success of the system are largely if not wholly overcome. The chief of these was the *handling* of the batteries. That was the most difficult and the last obstacle to be overcome by us. Two improvements removed these difficulties. First, the *flexible connector*, which enables us to couple up or remove cells with great rapidity, and secondly, the battery rack, occupying a floor space of 24ft. by 7ft. on each side of the car, wherein we can store a sufficient number of batteries to run from 10 to 20 cars, according to its location. This rack represents stall room for 150 horses, or, say, 6,000 square feet. I regard this rack as the greatest improvement hitherto made in storage battery traction. By its aid we remove the batteries from a car and replace them by another set in from two to three minutes; indeed our cars on Madison-avenue—and I may say here that we begin to-day to run ten (10) in daily service—have to leave the station on six (6) minutes' headway. In the afternoon trips there is but six minutes interval between their arrival and departure; and they all receive their batteries from the same rack. When the car enters this rack, its panels are dropped down on either side, and thus form bridges over which the batteries are withdrawn from and replaced in the car. While this change is being made, a competent person inspects the regulators of the cars; the motors, gearing and connections are only inspected once a day, and that at the end of the day's work. You will thus perceive that the great bug-bear of how to store the batteries is no longer an element in storage battery traction.

From my observation of our recent work on Fourth and Madison-avenues, now that we are running a number of cars and under very unfavourable conditions as to station room and the like, I am led to believe that the storage battery car is as free, if not freer, from accident, as cars that are

* Paper read at the meeting of the above Association, held at Niagara Falls, August 7, 1889.

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run by the overhead system. The motors are, I think, subjected to less trying conditions, owing to the fact that the E.M.F. is always uniform. The batteries give neverout on the trip. It is impossible for them to do so, as they leave the station with 35 electrical horse-power hours stored in them, and do not consume quite 12, in the round trip of 12 miles. We have never short-circuitted the battery in service. When the current required exceeds 150 amperes, the battery is automatically cut out. When we used rigid connectors, we frequently had difficulty with their breaking, and the flexible connector has, until recently, give us some trouble, from time to time by jumping out of position while the car is in service; but with our recent improvements disconnection of the batteries while the car is in service is now rendered almost impossible. For several months past we have had absolutely no trouble from our regulators. In any event there are two on the car, so that if one should fail the car may be operated from the other end. You will thus perceive that the likelihood of accidents or breakdowns is reduced to a minimum. Our first standard car has run in three months over 6,000 miles, and carried over 80,000 passengers, never having missed but one-half a trip in that time, and that arose from a bent axle. It has never had an accident or stoppage of any kind while in service. Do not be sceptical at the assertion when I tell you that we have never spent a dollar on that car in the way of repairs or alterations.

At this stage you will naturally ask, how about the life of the battery? I answer that from our observation we have nothing to fear on that score. We only ask a life of six months from the positive plates; we know that they will last very much longer than that. The chief reasons why the short-livedness of a storage battery has been so much talked about and feared is that it has until recently cost so much to manufacture the battery. Now the material for your battery you have to buy, in a great measure, but once, for the reason that the discarded battery can be made over new. The raw material in two sets of battery, capable of running a car 120 miles a day, costs, exclusive of the containing jars, about $300. Have you machinery and devices requisite for manufacturing this raw material cheaply into a battery? If you have, you need have nothing to fear on the score of economy. It will cost $4,000 to purchase enough horses to run a 16 foot car 120 miles a day; it will cost about $1,500 to purchase enough battery to do that work. The batteries can be maintained for about one-half what it costs to maintain the horses, and by maintaining I mean replacement as well as feed. This I know for a fact. Can we then have any further doubt as to the relative economy of storage battery traction.

Our cars on the Madison and Fourth-avenue line take one electrical horse-power hour per mile. The road has some long gradients. The grade at Centre-street is over 4½ per cent., and 600ft in length.

The cost of motive power for a car day of 75 miles we estimate at $3·40, as against $7·50 for horses. Five dollars for 75 miles ought to cover the cost in winter. By motive power we mean the cost of energy at two cents per horse-power hour, and $700 per annum for maintenance of batteries and motors. To those who may think that two cents per horse-power is a low estimate, we would say that power has been offered to us in New York, to be delivered to us at our station at the price above-named. In towns outside of New York offers have been made to supply current at lower figures. The more level the roads the cheaper obviously will be the cost of motive-power. This is more particularly true of the storage battery which, in excessively steep and long grades, becomes heated. The chemical energy instead of exhibiting itself in the form of electrical energy, exhibits itself in the form of heat, with consequent injury to the battery. Our cars will ascend very steep grades; but we do not deem it economical to attempt grades of more than 6 per cent., and they must be short at that rate. But there are few roads offering more and steeper grades than the road we are now operating on in New York. Each car has two sets of battery. A set is easily charged in about two-thirds of the time the other is in service. No time is lost in charging, as the battery is automatically put in circuit with the dynamo as soon as it is withdrawn from the car. Now that we have a complete group of cars in service in New York, and hope to follow those by another 10, we shall all know more about storage battery traction at our next annual meeting.

LIGHTNING, LIGHTNING CONDUCTORS, AND LIGHTNING PROTECTORS.*

(Concluded from page 384.)

Appendix I.

Theory of B *Circuits, of "Alternative Path" Experiments, and of Side Flash.*

Consider a couple of jars connected to the terminals of a machine by their inner coats and to a wire circuit by their outer coats (Fig. 1).

They form an ordinary circuit with a capacity inserted equal to the semi-harmonic mean of the two jars separately, and an air gap of adjustable width at A; and the maximum difference of potential producible in it is determined by the distance of the A knobs. When the discharge occurs, a current flows of course equally round the whole circuit, but the peculiarity is that up to the instant of discharge the B portion of the circuit is at a uniform potential. If a gap exists in B also, as it well may, the terminals of the gap may likewise be at the same potential up to the instant when the rush occurs. The discharge will, as usual, be oscillatory unless the resistance of the whole circuit be too great; and the period of oscillation will be approximately $2\pi\sqrt{(L S)}$, where S is the capacity of the two jars in series.

Now number the coatings of the two jars as shown in the diagram, and write down their electrical condition before and during the discharge spark at A:—

	Plate 1.		Plate 2.		Plate 3.		Plate 4.	
	Charge	Potential.	Charge	Potential.	Charge	Potential.	Charge	Potential.
Before discharge	+Q	+V	−Q	−V	−Q	0	+Q	0
After ¼ period	0	0	0	0	0	−V	0	+V
After ½ period	−Q	−V	+Q	+V	+Q	0	−Q	0
After ¾ period	0	0	0	0	0	+V	0	−V
After a whole period	+Q	+V	−Q	−V	−Q	0	+Q	0

and so on, with gradual damping (the damping being omitted in the table for simplicity).

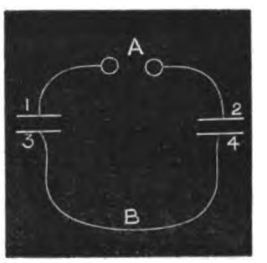

Fig. 1.

Thus, then, between the ends of the B wire exists at regular intervals almost the whole difference of potential which is able to jump the air gap at A. Strictly speaking, the difference of potential is rather less than that corresponding to the A gap; thus the equation to the current at any instant is accurately

$$C=\frac{V_0}{p L}e^{-\frac{R}{2L}t}\sin p\,t,$$

where V_0 is the initial difference of potential corresponding to the A spark, and where

$$p=\sqrt{\left(\frac{1}{LS}-\frac{R^2}{4L^2}\right)}.$$

Now, if L_1 is the portion of the whole self-induction which corresponds to the B length of wire (*i.e.*, subtracting from the whole L the part belonging to the A wire), and if R_1 is the resistance of the B wire, its impedance is $\sqrt{((p L_1)^2+R_1^2)}$; and while a current, C, is flowing through it, the difference of potential between its ends is therefore $\sqrt{((p L_1)^2+R_1^2)}\,C$.

Now the current flowing through attains its maximum value one-quarter period after the A spark has commenced, *i.e.*, in a time

$$\frac{\pi}{2p};\left(\text{more exactly, in a time }\frac{1}{p}\tan^{-1}\frac{2pL}{R}\right);$$

and inserting this in C we get the maximum possible strength of current, viz.:—

$$C_1=\frac{V_0}{pL}e^{-\frac{\pi R}{4pL}}.$$

Hence the maximum possible difference of potential between the ends of the B wire is

$$V=V_0\,\frac{\sqrt{\left\{L_1^2+\left(\frac{R_1}{p}\right)^2\right\}}}{L}\cdot e^{-\frac{\pi R}{4pL}};$$

that is, a certain fraction of V_0, the fraction being

$$\frac{\text{total impedance of B wire}}{\text{inertia impedance of whole circuit}}\times\text{damping during }\tfrac{1}{4}\text{ period.}$$

Very often a sufficient approximation to this is

$$\frac{L_1}{L}e^{-\frac{\pi R}{4pL}};$$

and if the wires are thick and short, or non-magnetic, and the

* From the *Journal* of the Institution of Electrical Engineers, being the reply of Dr. Lodge to the discussion on "Lightning, Lightning Conductors, and Lightning Protectors."

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capacity big, the damping during the first quarter of a period is often so small that merely the fraction $\frac{L_1}{L}$ will do sufficiently well.

So then, if a supplementary pair of tapping knobs be connected to the ends of the B wire, as shown in Fig. 2, and if their distance be adjusted to be $\frac{L_1}{L}$ths of the A distance, a spark is liable to pass at these knobs.

This is what I call a B spark, and the spark gap affords an alternative path to the B wire, or *vice versâ*.

There is no need to tap off the *whole* of the B wire. Any portion, however small, will serve, provided the appropriate value of L_1 is used. The length of the B spark measures the difference of potential needed to propel the current through the portion of wire which is thus tapped. Of course, if a B spark actually *occurs*, it introduces disturbance; the knobs should be set so that it just fails.

There is one thing not here explicitly stated, but which has to be taken into account in calculating the value of R, and that is the loss of energy by radiation. With small jars and circuits this loss is very great, and it increases the value of R enormously. See a Paper of mine in the forthcoming July *Philosophical Magazine*. With big jars and circuits it may be safely omitted; the experimentally observed B spark will agree with calculation. But with small jars, if it be omitted, the observed B spark will be always less than the calculated.*

In this way a measure of the damping due to radiative dissipation of energy can immediately be made.

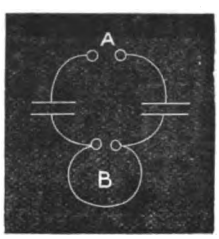

FIG. 2.

The observation of Mr. Wimshurst about the neutral point indicates at once that this theory also gives the length of side flash obtainable from the wire. Let any part of the B wire be put to earth, or let its natural neutral point be found, then the V calculated as above for any other point gives the length of side flash obtainable from that point to earth.

Side flash is in fact a special case of the alternative-path experiment. With a symmetrical wire like this, everything insulated and the jars equally charged, the neutral point is naturally the middle. But with a lightning conductor the lower end is to earth more or less completely, hence from the actual bottom of the wire no side flash should be obtainable. One always will be obtainable, however, owing to the impossibility of making a non-resisting earth of infinite capacity. Higher up, the length of side flash obtainable must be its length at the bottom plus the V corresponding to height of point tried. The maximum side flash is obtainable from the top of the wire. The strength or energy of the spark depends, of course, on the capacity of the body receiving it (if insulated); being $\frac{1}{2}$ S V^2, when V is calculated as already said. If it be an earthed body, then the whole discharge divides itself between the two paths, according to the laws of divided current appropriate to these conditions.

In testing a conductor, a spark should be given to the top, and the length of side spark obtainable at the bottom should be observed. All else can be calculated, except in so far as there may be defects in the visible portion of the rod.

APPENDIX II.

Resistance and Impedance for Frequencies Comparable to a Million per Second.

If $\frac{p}{2\pi}$ is the frequency of current conveyed by a wire of length l, and of ordinary resistance r, made of a substance of permeability μ; then its resistance to currents of excessively high frequency is

$$R = \sqrt{(\tfrac{1}{2} p l \mu r)},$$

hence the resistance of soft iron is immensely higher than that of any non-magnetic metal.

The self-induction under the same circumstances is

$$L_0 + \frac{R}{p},$$

where L_0 refers solely to the space surrounding the conductor.

The inertia portion of the impedance is*

$$p L_0 + R,$$

of which the first term is far the bigger at high frequencies, even for iron, unless the wire is very thin.

The total impedance is

$$\sqrt{(p^2 L_0^2 + 2 p L_0 R + 2 R^2)},$$

of which, again, the first term usually far eclipses the others.

Numerical Examples.—1. Let the length l, of conducting rod be 10 metres, its diameter 1 centimetre, and let it be bent into the form of a circle (if it be straight, there will be but little difference); take $\mu = 1$ for copper, or 900 for iron; specific resistance, 1,600 square centimetres per second for copper, or 7 times this for iron; and let $p = 2\pi \times 10^6$ per second.

Then, whatever the substance of the conductor,

$$L_0 = 12{,}000 \text{ centimetres};$$

while the common resistance,

$$r = \begin{cases} \cdot 002 \text{ ohm for copper.} \\ \cdot 014 \text{ ohm for iron.} \end{cases}$$

Hence the effective resistance is

$$R = \begin{cases} \cdot 08 \text{ ohm for copper.} \\ 6 \cdot 3 \text{ ohms for iron.} \end{cases}$$

The inertia portion of the impedance is,

$$p L_0 + R = \begin{cases} 75 \cdot 4 + \cdot 08 = 75 \cdot 5 \text{ ohms for copper.} \\ 75 \cdot 4 + 6 \cdot 3 = 82 \cdot 0 \text{ ohms for iron.} \end{cases}$$

The total impedances are practically the same—viz.,

$$\begin{cases} 75 \cdot 5 \text{ ohms for copper.} \\ 82 \cdot 0 \text{ ohms for iron.} \end{cases}$$

2. If, instead of taking a rod 10 metres long, we consider a length 100 metres long, of the same thickness, these quantities become:—

$$L_0 = 162{,}000 \text{ centimetres.}$$

$$r = \begin{cases} \cdot 02 \text{ ohm for copper.} \\ \cdot 14 \text{ ohm for iron.} \end{cases}$$

$$R = \begin{cases} \cdot 8 \text{ ohm for copper.} \\ 63 \cdot 0 \text{ ohms for iron.} \end{cases}$$

$$\text{Inertia part of impedance} \begin{cases} 1{,}003 \text{ ohms for copper.} \\ 1{,}066 \text{ ohms for iron.} \end{cases}$$

$$\text{Total impedance} \begin{cases} 1{,}003 \text{ ohms for copper.} \\ 1{,}067 \text{ ohms for iron.} \end{cases}$$

3. Lastly, for a wire 100 metres long, but 1 *millimetre* in diameter, the values would be

$$L_0 = 208{,}000.$$

$$r = \begin{cases} 2 \text{ ohms for copper.} \\ 14 \text{ ohms for iron.} \end{cases}$$

$$R = \begin{cases} 8 \text{ ohms for copper.} \\ 630 \text{ ohms for iron.} \end{cases}$$

Inertia part of impedance,

$$p L_0 + R = \begin{cases} 1310 + 8 = 1{,}318 \text{ ohms for copper.} \\ 1310 + 630 = 1{,}940 \text{ ohms for iron.} \end{cases}$$

$$\text{Total impedance} \begin{cases} 1{,}318 \text{ ohms for copper.} \\ 2{,}040 \text{ ohms for iron.} \end{cases}$$

All this supposes the frequency to be determined independently of the conductor considered, and to remain the same; but as the conductor increases in length it has a tendency to decrease the frequency; and that is the meaning of my sentence in Section 28, to which Major Cardew objects, "and of any moderate length, such as 100 yards or less (not many miles)."

I ought to say that the here calculated values for R do not take into account at all the loss of energy by radiation. This will always go to increase R, often very perceptibly, sometimes enormously. I will go into this further in some other place.

These examples illustrate sufficiently well the comparative behaviour of iron and copper under well-marked and frequently-occurring conditions. I have chosen the frequency of a million a second, because I have shown reason for believing that it is not at all unlikely to apply to the circumstances of lightning; the capacity discharged per flash, and the self-induction of its path, being neither of them very big.

* See *The Electrician* for 21st June 1889.

* At first sight it may seem as if I were making a mistake in having an R term in the purely inertia part of the obstruction, but it is quite right. This term R happens to represent exactly the magnetisation of the substance of the wire, so far as its outer skin is magnetised.

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But while we are about it, it is instructive and quite easy to write down the values for some considerably lower frequencies; not for slow frequencies such as alternating machines give, the theory for them is more complicated, but the simple theory will do for, say, 10,000 complete periods per second. The result will be distinctly different. No longer does inertia constitute the whole of the obstruction for iron, though it still does for copper; and for iron it constitutes the largest part.

Frequency, 10,000 per second.		Resistance, R.	Inertia part of Impedance ($p L_0 + R$).	Total Impedance.
		Ohms.	Ohms.	Ohms.
10-metre rod 1 cm. thick	copper.	·008	·762	·762
	iron ...	·63	1·384	1·52
100-metre rod 1 cm. thick	copper.	·08	10·11	10·11
	iron ...	6·3	16·96	18·1
100-metre wire 1mm. thick	copper.	·8	13·9	13·9
	iron ...	63·	76·1	98·8

The depth penetrated by the current into the substance of the wires, is definite at a given frequency, unless the wire is too thin to leave a central margin, and is independent of the diameter of the wire; at least for these high frequencies. It is easily calculated with fair approximation, thus the sectional radius of the wire being a:—

$$\frac{2\pi a\, da}{\pi a^2} = \frac{r}{R},$$

whence da, the depth effectively penetrated by the current, or the thickness of conductor practically made use of, is—

For the million per second frequency { in copper $\frac{1}{15}$ millimetre; in iron $\frac{1}{180}$,,

For the ten thousand per second frequency { in copper $\frac{1}{15}$ mm.; in iron $\frac{1}{18}$,,

It may be after all, therefore, that I am wrong in saying that rod is anything approaching as good as tape for conductors. It is nearly as good in respect of mere impedance, but whenever there is any chance of the wire being melted, then tape is far better. Rod ought to be apt to have its skin burnt off, unless the central core has time to exert any cooling action by sharing the heat.* But it is because I doubt whether decently substantial conductors are in any real danger from heat that I have asserted the advantage of greater surface to be but small.

I wait, however, for an expression of authoritative opinion from the President on these points.

Appendix III.

On the Melting of Conductors.

The list of fused conductors at the end of the Lightning Rod Conference Report, Appendix J, is very short, but short as it is it includes things not quite free from serious misleading. Over and over again it has been truly asserted that wherever there is an arc or a flash to a conductor damage is likely to be done. Terminals which have to receive the flash should always be thicker than the wire which has only to conduct it. This must be regarded as very ancient and orthodox, as well as very true. I now run through the short list of damage and analyse it. The table is headed "List of Metals Melted."

1. "Copper rod, ·35 inch diameter." This was an upper terminal, tapering from one-third of an inch diameter at the *base* to a point, and only 9½in. long altogether. This terminal was "nearly all melted."

2. "Copper rope, ·31 inch diameter, at Nantes." Callaud, "Traité," p. 89.

3. Rope, *said* to be ·7 inch diameter, at Carcassone. Callaud, "Traité," p. 89.

These I will refer to directly. They were not fused, but broken, or eaten into, or otherwise "burnt by use."

4. "Iron rod, ·2in. diameter." This was a few inches melted from the *point* of an upper terminal, and some of the links of a *chain*.

5. "Brass rod, ·2in. diameter." This was a tapering terminal, 10in. long, of the given diameter at the *base*, and it was only melted for one-fourth of its length.

The implied *statement* in the report is, therefore, that a brass rod ¼ of an inch in diameter was melted. The *fact* is, that 2½ inches was melted off a sharp brass point! Fortunately in this case, and in case 1 also, the body of the report itself contains the material capable of overthrowing this misrepresentation.

6. "Copper rod, *perhaps* ·13 inch diameter." This was a common bell-wire, and it was legitimately destroyed, but still it protected.

That is the whole list, and it amounts to nothing more than a bell-wire, and to cases 2 and 3, the account of which I now proceed to translate from the treatise of M. Callaud. The Carcassone case is one of the two Mr. Symons quotes in his remarks (the other is case No. 4, above). It is the only one that sounds improbable, and the evidence for it seems to me weak; but I leave readers to judge. The evidence for the Nantes cases, such as they are, is perfectly good.

Extract from "Traité des Paratonnerres," par A. Callaud, p. 89:—"The conductor of the Church Santa-Croix at Nantes was a cable of red copper, a centimetre in diameter; it was formed of seven strands, each consisting of seven wires, the wires being one millimetre thick. I was witness of a storm and of violent flashes which traversed it, and it showed no trace of deterioration. This size can therefore be permitted, though it seems to me slight. The cable which existed before that of which I speak, also of red copper, was found broken by a flash and damaged over a part of its length; il avait eight millimetres. I know of conducting bars, five millimetres, which a single storm has deteriorated and eaten into in a way that ten years of rust would hardly accomplish.

"M. Viollet-le-Duc, whose words I have had the honour of quoting, has seen at Carcassone some cables of lightning conductors burnt by use. Ils avaient 18 millimetres. 'In this town,' he tells me, 'storms are frequent—daily, in certain seasons.' In such a case the size of 18 millimetres will be then insufficient."

This last is a most vague account. The material is not specified, nor is it perfectly certain whether the 18 millimetres refer to the diameter, or whether it means that it consisted of 18 wires, each a millimetre thick. Evidently, however, M. Callaud supposes it to mean the diameter, and most likely it does. But why in the plural? And does "burnt by use" mean anything more than that some of the thin wires were burnt or fused together, or that the cable was oxidised superficially?

Considering the exceptional character of the testimony, if understood in the Lightning Rod Conference sense, it is a pity it is second-hand.

Appendix IV.

On Conditions under which Points can be Preferentially Struck in Case B.

Referring to Mr. Wimshurst's observation of the effect of the sign of top-plate, the following is an extract from an April note book kept by my assistant:—

"Large sphere (or dome), knobs, and point, arranged between two plates so as to be equally struck by a B spark. The plates are connected to the outer coats of the two small or pint jars, whose inner coats are connected to the machine, between whose termina's occurs a moderate A spark.

1st. *With the top-plate positive.*

Distances of	Dome	2·5	centimetres.
	Large Knob	3·6	,,
	Small knob	3·8	,,
	Point	3·8	,,

2nd. *Top-plate negative.*

Distances	Dome	2 5	centimetres.
	Large knob	3·0	,,
	Small knob	3·7	,,
	Point	8·0	,,

Lengthening the A spark makes the distance at which the point is struck less."

The following measurements have been made quite recently, large jars being used, but the vigour of the rush being diminished in some cases by making the A spark (*i.e.*, the distance between the machine terminals) quite short.

Two gallon jars similarly connected, instead of the pint jars. Objects arranged between plates to be easily and about equally struck, as before. First, with the A spark 1 centimetre long.

Top-plate negative.

Distances from top-plate of	Large knob	1·2	centimetres.
	Small knob	1·4	,,
	Point	2·4	,,

Top-plate positive.

Distances of	Large knob	1·5	centimetres.
	Small knob	2·2	,,
	Point	2·3	,,

* The specimens exhibited by Mr. Preece, of copper wire incipiently fused by lightning internally, are interesting. They may have been fused by the dead-beat tail of a current; the outside cooling most rapidly. They *look* as if they had been hottest inside, and if so an explanation is needed; but they are not likely to upheave the foundations of electro-magnetism.

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Lengthen A spark to 5 centimetres—

Top-plate negative.

Distances of { Large knob ..... 3·4 centimetres. Small knob ..... 3·5 ,, Point ..... 3·9 ,,

Top-plate positive.

{ Large knob ..... 4·0 centimetres. Small knob ..... 4·2 ,, Point ..... 3·9 ,,

Repeat with A spark *about* 5 centimetres, but the B distances made greater.

Top-plate positive.

{ Large knob ..... 5·4 centimetres. Small knob ..... 4·7 ,, Point ..... 4·7 ,,

Top-plate negative.

Distances unaltered, and all are struck occasionally as before, but the small knob gets struck rather more often than the others, and the large knob rather less often.

Hence, it is clear that under circumstances when the rush is really *impulsive*, the difference between positive and negative top-plate, which Mr. Wimshurst called attention to, does not exist. It nly exists in so far as the rush is gradual.

WATER-SPRAY INFLUENCE MACHINE.*

BY GEORGE FULLER.

This machine is for obtaining directly from a fall of water a supply of electricity of a high potential. It consists of four similar parts arranged symmetrically round a central vertical support (Fig. 1.), and each division has the following members :—

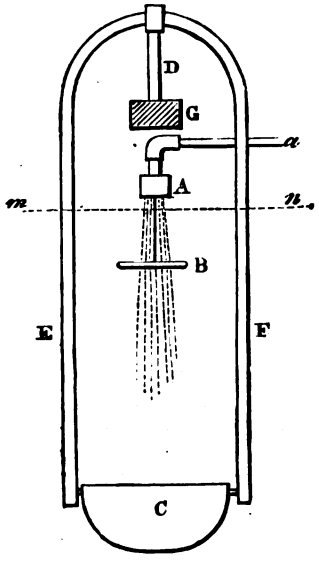

Fig. 1.

A nozzle, A, in connection with a head of water by means of a pipe, *a*.

A ring, B, of brass or copper wire placed vertically below A, and through which the water descends when the machine is in action.

A vessel, C, placed below B to receive the water that has passed through the ring.

A brass tube, E F, between the ends of which the vessel C can turn about a horizontal axis.

An insulating glass rod, D, to the top of which the tube E F is attached, and with the lower end fixed in a part of the frame of the machine G.

A sectional plan on *m n* (Fig. 2) shows the connection between the four divisions, which are numbered I., II., III., IV. The wire ring of section I. is in electrical connection with the receiver of section IV. Similarly the ring of II. is connected with I., the ring of III. with IV., and that of IV. with I.

* Paper read before the Physical Society.

K is a central column for supporting four arms of the machine to which are fixed the insulators D.

The discharge of electricity is taken between conductors in connection with II. and III.

The nozzle is a flanged brass box, the bottom of which is perforated with small holes through which the water descends. It is fixed by a number of small bolts and nuts through its flange to a brass plate fixed to the supply pipe *a a* (Fig. 3), and the joint is made watertight by a vulcanised india-rubber ring. A piece of fine linen covers the top of the box to strain the water before it reaches the small holes, as it was found that the water was either stopped or diverted by small particles unless this precaution was taken. The holes, which are circular, have a diameter of $\frac{1}{100}$"; as it was found that when holes $\frac{7}{1000}$" were used the water was so much dispersed by the working of the machine that a great part of the water ceased to fall into the receivers. This great dispersion also injured the insulation, and besides this it was extremely difficult to keep these holes free.

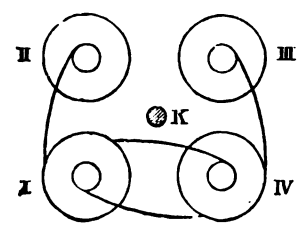

Fig. 2.

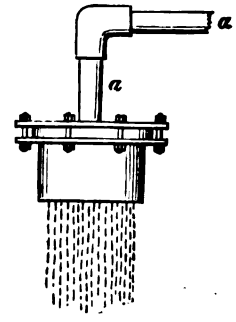

Fig. 3.

With regard to the number of holes : In the nozzles of sections I. and IV. there are six arranged in a circle of $1\frac{1}{4}$" diameter ; for those of sections II. and III., either a pair with twelve holes each in a circle of $1\frac{1}{4}$" diameter, or with eighteen holes in a circle of $1\frac{3}{4}$" diameter.

The rings are made of brass or copper wire of about $\frac{1}{8}$" diameter. The inside diameter of the rings used with the nozzles with six and twelve holes is $2\frac{1}{4}$", and with the eighteen holes $2\frac{3}{4}$".

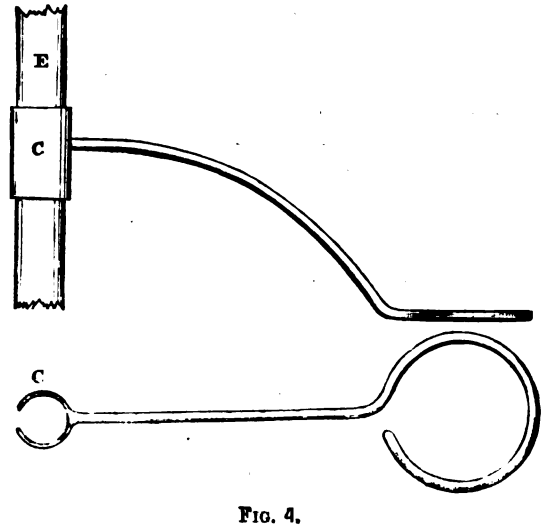

Fig. 4.

The wire of each ring is continued and fixed to a clip of split brass tube, C (Fig. 4), which slides upon the brass tube E or F. This enables the depth of the ring below the nozzle to be adjusted, which is of importance, as the greater the head of the water employed the greater must be the distance between the two, as the ring should be fixed at the point where the small streams of water break up into spray. The receiving vessel C (Fig. 5) may be of glass or metal, as the former material, from its constant state of moisture whilst the machine is working, seems to conduct the electricity as effectually as the latter. In the author's model they were at first of glass, but one of them having been broken they were replaced by receivers of zinc. The receivers are supported by pins, *p*, *p* which are soldered to them at one end, whilst their free ends rest in holes drilled in E and F. To make the receiver self-acting they are hung so that when a leaden weight, *w*, is fixed, as shown in sketch, the vessels being empty, they would turn in the direction of the arrow (Fig. 6) if they were not prevented by s ops soldered to them which press against E and F ; but when the receivers are nearly full of water, their balance is such that they

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turn in the opposite direction and so empty themselves. The four receivers are made to turn towards the axis of the machine and to deliver the water into a metal bath, which for continuous action should be connected with a drain.

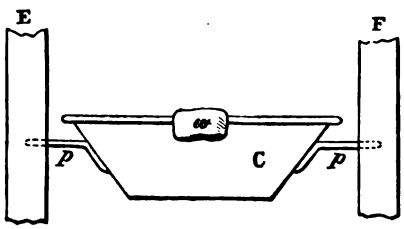

FIG. 5.

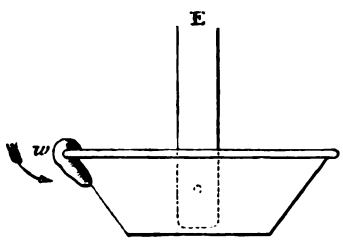

FIG. 6.

The following are some of the dimensions of the author's model (Fig. 7) :—

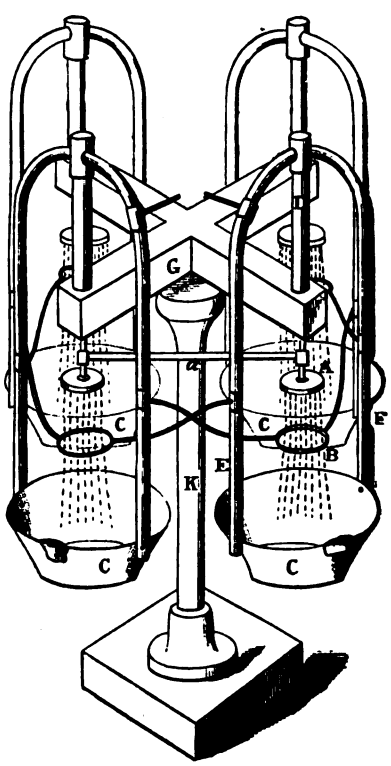

FIG. 7.

Zinc receivers 8″ diameter at the top.
Brass tube E and F $\frac{3}{8}$″ diameter.
Glass rod D $\frac{3}{4}$″ diameter, with an insulation of 4″.
From the rim of C to the lower surface of A, 9$\frac{1}{4}$″.
From the rim of C to the underside of stand, 1′ 1″.
From centre to centre of insulators D across the centre line of instrument, 1′ 11″.

The Electrical Action of the Machine.

An instrument made of only sections I. and IV., with their rings connected with their receivers, as shown above, will charge itself ; and the difference of potential of the two receivers may be such that sparks $\frac{1}{2}$in. long may occasionally pass between them, though more usually $\frac{3}{8}$in. is the longest that can be obtained with a head of water of about 23ft. With this arrangement, after every discharge the potential of the rings is nearly equalised ; whereas in the machine with four sections, I. and IV, keep up the difference of potential of the rings of II. and III.

With respect to the action of the machine, the author, whilst giving the considerations from which it was constructed, must leave to the electrician to determine whether they have anything to do with the true explanation of the phenomena. The water, at the point where it is divided into drops by the resistance of the air, is electrified by induction from the rings, the former being in connection with the earth through the unbroken water of the stream ; and the action seems similar to that employed in Sir W. Thomson and Prof. Silvanus Thompson's water-dropping accumulators. That such is the case appears to follow from the fact that, if the rings are either placed much above or much below the level where the water breaks into spray, the machine ceases to work. When the rings are at their proper level there is an additional action ; for the particles that are inductively electrified are split up into numberless minute particles, some of which are so fine that they float about in the air and do not fall into the receiver. And it is this breaking up of the water into minute particles that the author thinks may account in part for the effect produced ; for when a number of spheres that have been electrified unite into a mass of less surface, their potential in the latter state is higher than in the former.

Another point which the author thinks must be taken into consideration is the speed with which the particles move through the ring, as it was only when he experimented with a fall of some feet instead of inches that he obtained a potential high enough to produce sparks. With a very slow speed the attraction of the ring is too strong for the water, so that it at last, as in Sir William Thomson's apparatus, bends against it. That the division of the drops into minute spray plays a part in the action of the machine seems to be shown by the fact that sparks of the same length, in the same state of the atmosphere, have been obtained from it when the velocity of the water has been very much diminished. The sparks, as a rule, have not been so numerous per minute, but the water has been divided into finer spray. At times, even with half the delivery of water, the same length of spark has been obtained.

One experiment the author has made in which the spray was not obtained by the action of gravity, but by a steam "atomiser," as it is called. The water and steam passed through a copper wire ring 1$\frac{1}{2}$″ diameter, connected with one of the receivers of an apparatus made up of sections I. and IV., as above. The nozzle was $\frac{5}{8}$″ from the ring and 5$\frac{5}{8}$″ from the receiver. Sparks $\frac{1}{4}$″ in length were taken freely from the receiver, which is a better result than has been obtained with a fall of water of some 23ft. What was very observable in this case was the very small amount of water used, a small teacup-full being passed over in some five or six minutes ; and the author has recorded in his notes that the experiment was made on a very wet day.

Adding to the number of jets does not seem to increase the power of the machine, either in quantity or potential, at all in proportion to the number added ; though the action of an electrical machine is so eccentric that it is difficult to be certain of this, for at times the nozzle with 18 jets has given much better results than the one with 12 jets.

It has been stated that in the machine as made the rings are 1″ larger in diameter than the circle of the jets, and it is found that they give a better result than when larger rings are used ; but in some experiments with a small flow of water a ring 3$\frac{1}{2}$″ diameter gave as a large a spark as one of 1$\frac{1}{2}$. In the dark electricity is often seen to fly off from the rings, the water on them being made into pointed-shaped drops.

The machine in its present form is by no means powerful, as with a small Leyden jar attached to it the longest spark has hitherto been 1$\frac{1}{8}$″, the head of water being about 23ft. The state of the atmosphere has very great influence on the working of this machine, for though in all states of the weather electricity will be generated, it requires a fairly dry atmosphere to give 1″ sparks.

It may be mentioned that the machine has only been tried in a small bath-room, which is a very unfavourable place for electrical experiments ; and it perhaps is worth mentioning that on one occasion sparks were only obtained when window and door were open and the machine was in a thorough draught.

To what extent the power of the machine may be increased it is difficult to predict ; but the author thinks that the experiment with the atomiser points to high velocity in the water, combined with minute subdivision, as the direction in which any future attempts should be made.

An Electro-Medical Vaporiser.—An ingenious apparatus has been devised by a Dr. Telschow for the purpose of vaporising solid medicaments, and it has already rendered great service in connection with throat complaints. The apparatus consists of an india-rubber syringe, traversed by a piece of platinum wire. This wire is covered with the powder medicament, and a strong current of electricity is sent through it. The wire becoming incandescent the powder is vaporised and is carried by the current of hot air in the required direction.

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THE BOARD OF TRADE RULES FOR OVERHEAD WIRES.

The following regulations have just been issued by the Board of Trade :—

In these regulations the words, terms, and expressions to which by the Electric Lighting Acts, 1882 and 1888, meanings are assigned, shall have the same respective meanings, provided that in these regulations—

"Energy" means electrical energy, and for the purposes of the Electric Lighting Act, 1888, and these regulations, electrical energy shall be deemed to be an agency within the meaning of the word electricity, as defined in the Electric Lighting Act, 1882.

"Conductor" means an electric wire or line used for the supply of energy.

"Aerial conductor" means a conductor which is placed above ground and in the open air.

"Low pressure conductor" means a conductor in which the difference of electric potential either between that conductor and earth or between that conductor or any part thereof and any other conductor on the same poles or supports does not exceed 300 volts, if the supply be on the continuous-current system, or the equivalent of 150 volts if on the alternating-current system. A difference of potential on the alternating-current system shall be deemed to be the equivalent of a difference of potential on the continuous-current system, when it produces an equal heating effect if applied to the ends of a thin-stretched wire or carbon filament.

"High-pressure conductor" means a conductor in which the difference of electric potential as above described is greater than that of a low-pressure conductor.

Regulations.

1. An aerial conductor in any street shall not in any part thereof be at a less height from the ground than 20ft., or where it crosses a street 30ft., or within 6ft. of any building or erection other than a support for the conductor, except where brought into a building for the purpose of supply.

2. Every aerial conductor shall be attached to supports at intervals not exceeding 200ft. where the direction of the conductor is straight, or 150ft. where this direction is curved, or where the conductor makes a horizontal angle at the point of support.

3. Every support of aerial conductors shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the conductors, or unequal lengths of span, and the conductors and suspending wires (if any) must be securely attached to insulators fixed to the supports. The factor of safety for the suspended wires shall be at least 6 and for all other parts of the structure at least 12, taking the maximum possible wind-pressure at 50 pounds per square foot. No addition need be made for a possible accumulation of snow.

4. Every support, if of metal, shall be efficiently connected to earth, and if of wood or other non-conducting material, shall be protected from lightning by a lightning conductor fastened to the support along its entire length, and projecting above the support to a height of at least six inches, such lightning conductor being efficiently connected to earth.

A support shall be efficiently connected to earth when it is connected to metallic mains for water supply outside of buildings, or, where these are not available, to a mass of metal having a total surface of at least four square feet, buried to a depth of at least three feet in moist earth, provided that in either case the connecting conductor must possess a mechanical strength, and offer a passage to electrical discharges, equal to that of a strand of seven No. 16 galvanised iron wires.

5. Every aerial conductor shall be protected by efficient lightning protectors of pattern approved by the Board of Trade.

6. Where any conductor crosses a street the angle between such conductor and the direction of the street at the place of such crossing shall not be less than 60 degrees, and the spans shall be as short as possible.

7. Where an aerial conductor is erected so as to cross any other aerial conductor or any suspended wire used for purposes other than the supply of energy, precautions shall be taken by the owners of such crossing conductor against the possibility of that conductor coming into contact with the other conductor or wire, or of such other conductor or wire coming into contact with such crossing conductor by breakage or otherwise.

8. The maximum working current in any aerial conductor shall not be sufficient to raise the temperature of the conductor in any part to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30deg. of Fahrenheit's thermometer, and efficient automatic means shall be provided which will render it impossible for this maximum working current to be by any accident exceeded to the extent of 25 per centum, even for short intervals of time ; and special care shall be taken that the cross sectional area and conductivity at joints is sufficient to avoid local heating, and that the joints are protected against corrosion.

9. Every high-pressure aerial conductor must be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation must not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation must be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic it must be efficiently connected to earth, so, however, as not to cause undue disturbance to other electric lines or works by electrostatic induction or otherwise.

10. The material used for insulating any high-pressure aerial conductor must be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 10°F. and 150°F., or to contact with the ordinary atmosphere of towns or manufacturing districts.

11. The insulation resistance of any circuit using high-pressure aerial conductors, including all devices for producing, consuming, or measuring energy, connected to such circuit, shall be such that should any part of the circuit be put to earth, the leakage current shall not exceed $\frac{1}{15}$th of an ampere in the case of continuous currents, or $\frac{1}{10}$th of an ampere in the case of alternating currents. Every such circuit containing high-pressure conductors shall be fitted with an indicating device which shall continuously indicate if the insulation resistance of either conductor fall below the conditions required by this Regulation.

12. Every aerial high-pressure conductor shall be efficiently suspended by means of non-metallic ligaments to suspending wires, so that the weight of the conductor does not produce in it any sensible stress in the direction of its length, and the insulated conductors and suspending wires, where attached to supports, shall be in contact only with material of highly insulating quality, and shall be so attached and guarded that in case they break away it shall not be possible for them to fall away clear of the support.

13. In the case of aerial conductors carrying alternating currents, the two conductors constituting the line and return for any circuit shall be run parallel with each other, and at a distance apart not exceeding 18in.

14. The owner of every aerial conductor shall be responsible for the efficiency of every support to which such conductor is attached, and every support shall be efficiently marked with such mark indicating the ownership of the conductor as the Board of Trade shall approve.

15. Every aerial conductor, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with such conductor, shall be duly and efficiently supervised and maintained by or on behalf of the owners as regards both electrical and mechanical conditions.

16. An aerial conductor shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the owners of such conductors intend within a reasonable time again to take it into use.

17. Every aerial conductor shall be placed and used with due regard to electric lines and works from time to time used or intended to be used for the purpose of telegraphic communication or the currents in such electric lines and works, and every reasonable means shall be employed in the placing and use of aerial conductors to prevent injurious affection, whether by induction or otherwise, to any such electric lines or works or the currents therein.

18. (*a*) A notice describing every aerial conductor erected or used for the supply of energy shall forthwith, upon receipt of these regulations, be served upon the Postmaster-General, together with a plan showing the mode and position in which such conductor is erected.

(*b*) The Postmaster-General, upon consideration of such notice and plan may require such alteration in the position or mode of erection, or mode of use of such conductor, or compliance with such other condition as he may think fit, having regard to the protection of the electric lines or works of the Postmaster-General, and any failure on the part of the body or person owning or using, or entitled to use, the said conductor to comply with such requirements shall be deemed to be a non-compliance with these regulations.

(*c*) Any notice required to be served upon the Postmaster-General under these regulations may be served by being addressed to him and left at, or transmitted through the post to, the General Post Office, London, and any notice required to be served on the body or person owning or using, or entitled to use, any aerial conductor may be served by being addressed to such body or person and left at, or transmitted through the post to, their or his office or last known place of address.

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CORRESPONDENCE.

ELECTRIC TRACTION ON THE BRUSSELS TRAMWAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your Note on page 368 in last week's issue, and the report of M. Michelet, it occurred to me that it is hardly fair to compare the working costs of three electric cars with those of a large and well organised system of horse cars. You state that "the cost of working the same line with horses is estimated at 25 centimes per car kilometre, and the cost of the electrical system, *exclusive* of maintenance of stationary machinery, royalties to the inventors, interest upon the capital, and depreciation of plant, but including the cost of maintaining the accumulators, comes out at the same figure." According to the report, the cost of renewing accumulators amounted to 9 centimes per car kilometre; the maintenance of car motors and the transmission apparatus was actually 5·74 centimes, leaving for steam power, &c., 10·25 centimes, in order to bring the total to the sum of 25 centimes per car kilometre. Converted into English equivalents we should have for—

Renewals of accumulators ...	1·44	pence	per	car mile.
„ motor and gearing	·92	„	„	„
Steam power.....	1·64	„	„	„
Total.....	4·00	„	„	„

This leaves no provision for depreciation of steam-power plant and dynamos. You have rightly pointed out that these cars are running over steep gradients, and that the lines are badly laid. I think there are few tram lines more difficult than those of the Rue de la Loi and the Rue Juste Lipse. Three cars cannot be as economically worked from one station as ten or twenty cars, whether by animal or by mechanical power, and the gain in economy is especially marked in the cases of electric and cable traction, where a whole system is fed from one large engine.

The manufacture of accumulator plates in Brussels is still carried out on a comparatively small and expensive scale, which renders the item of plate renewals very costly. Moreover, the type of plate used is not conducive to durability, as has been proved over and over again. Traction cells can now be made involving a depreciation of less than one penny per car mile, which would reduce this item on the Brussels tramcars by at least 30 per cent., and leave a good margin of profit to the manufacturer and patentee. One need not fear being thought hypercritical in pointing out that the maintenance of the car motors and gearing at Brussels is excessively high, viz., ·92d. per car mile. English cars run on an average 70 miles per day; this item would thus amount to £98 per annum per car, equal to about 50 per cent. on the gross value. Such figures reflect sadly upon the design and workmanship in the mechanism, and I am inclined to assume that M. Michelet included experimental work of some kind or another. Lastly, the balance of 1·64d. ought to cover amply the cost of fuel, attendance, maintenance, and depreciation of the engine, boilers, and dynamos at the charging station.

It seems to me that even with a very slight reduction in the above items of depreciation, but operating on a much larger scale (with economical engines and dynamos) the working costs of the Brussels electric tramway could be reduced to a fraction below horse traction, and with a more rational design there should be an economy sufficient to induce the Tramway Company to adopt electricity in preference to horses.—Yours, &c.,

A. RECKENZAUN.

London, August 19, 1889.

THE THEORY OF ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of August 9th, you invite cricitisms on the experiments and views of Mr. Mordey on the construction and behaviour of alternators, more especially as to parallel working. Mr. Mordey's Paper contained some extremely interesting experiments, some very valuable results, several opinions which cannot exactly be called theories because no explanation was proposed, but no data of the constructive details of the machine which would enable any numerical test to be made of any explanation that study would suggest. Now the difference between the old ideas on alternators and the new ideas proposed by Mr. Mordey, is this: the old idea was that alternators can only run together in parallel provided that there is in the circuit of the armatures, or their connecting wires, self-induction and resistance, Mr. Mordey says the perfect alternator is that which has no self-induction and no resistance. (Some authorities, notably Mr. Kapp and Prof. Forbes have, I think, made a point of having self-induction of considerable magnitude as of prime importance, but this is not strictly any part of the older idea which really lays special stress on a certain ratio between self-induction and resistance, and not on their absolute magnitude.) Now, although Mr. Mordey has laid down this proposition, he has not, so far as I am aware, made any suggestion as to the process by which two such dynamos, as he contemplates, control one another, and only offers as a proof the results obtained by experimenting with an alternator, in which, though the absolute values of the coefficient of self-induction and the resistance are small, still they admittedly exist, and their ratio, so far as I understand, is almost precisely what Dr. Hopkinson's formulæ predict as the most satisfactory value,* only that Mr. Mordey's coefficient of self-induction is still larger than the older ideas point out as desirable—that is, for a given output of machine his field-magnet requires further strengthening, and the armature turns diminishing. In the absence, therefore, of any experimental proof that two alternators will run in parallel without self-induction, and in the absence of any theory of why they should do so, the burden still lays with Mr. Mordey to prove that they will, and until that proof is afforded it appears to me that in view of the corroboration that Mr. Mordey's experiments give to the older idea, a certain scepticism as to the truth of his main proposition is allowable.

The fundamental axiom which rules all cases of running generators, either continuous or alternate, in parallel, is that the machine that leads (or accelerates) should take more load than the machine that lags (or is retarded). The older ideas give at least an explanation of how this result is produced in the case of two alternators in parallel with self-induction; but as yet Mr. Mordey has given no reason why, if there is no self-induction, the leader should have the greater load. What Mr. Mordey has done is this: he has shown experimentally that for efficient working in parallel we must work an alternator far below its maximum possible output, which Dr. Hopkinson's formulæ also indicates, and that this can only be done by keeping the internal resistance and self-induction small; he has not, I maintain, proved that they should both be absent, or that the ratio between them ought to have some value very different from that pointed out by Dr. Hopkinson. Neither has he proved that an alternator with iron in the armature cannot be made to satisfy the conditions of running in parallel as well as his own machine, whilst experiment shows that with properly designed iron-cored armatures all the experiments he described, including that of unequal volt generators, can be repeated with precisely similar results. I do not wish here to enter into any side issues suggested by some other experiments, but will conclude by asking "what experimental evidence or what theoretical reason is there, to suppose that two alternators, in whose combined armature circuit is no resistance and no self-induction, will run in parallel?"—Yours, &c.,

London, Aug. 19. LLEWELYN B. ATKINSON.

* Mr. Mordey states that the fall of potential of the alternator from light to full load is about double that due to the resistance of the armature alone, or the apparent resistance is twice the ohmic resistance, hence

$$\sqrt{R^2+\left(\frac{2\pi L}{T}\right)^2}=2R. \therefore R^2+\frac{4\pi^2L^2}{T^2}=4R^2. \text{ Hence } 3R^2=\frac{4\pi^2L^2}{T^2} \text{ and}$$

$$R=\frac{2}{\sqrt{3}}\frac{\pi L}{T}.$$

For Dr. Hopkinson's condition $R=\frac{2\pi L}{T}$ to be satisfied when the dynamos are coupled by leads of no resistance, the apparent R should be $\sqrt{2}\times$ the real resistance.

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AN IMPROVED LIGHTNING PROTECTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of last week, at page 375, we observe an attempt by Mr. A. R. Bennet to reinvent a well-known "Lightning Protector," combining points and fine-covered wire wound round an earthed cylinder, of which we have been the sole manufacturers for the last *thirteen* years.

A working model of the form of lightning protector was first brought to us by Mr. Andrew Jamieson (now Prof. Jamieson, of the Glasgow and West of Scotland Technical College) from

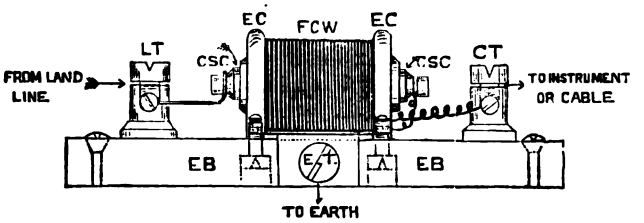

FIG. 1.—Jamieson s Lightning Protectors for Submarine Cables. (Side elevation.)

LT ..... Line terminal.	EC ..... Earthed cylinder screwed and insulated from CSC by
CT ..... Cable or telegraph instrument terminal.	EW..... Ebonite washer.
ET ..... Earth terminal.	EB..... Ebonite base.
CSC .... Central seriated cylinder.	FCW ... Fine covered wire.

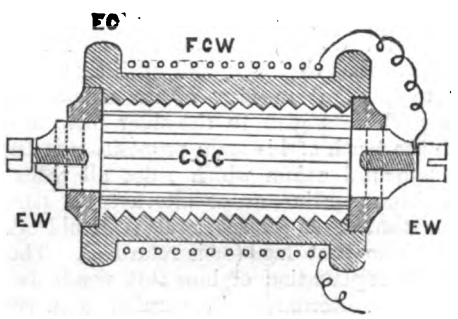

FIG. 2.—Jamieson's Lightning Protectors for Submarine Cables. (Longitudinal section through earthed cylinders.)

Brazil, in August, 1876. We have made and exhibited it in different forms at most of the large exhibitions, including the Glasgow International Exhibition last year, and we have sold them to the Eastern, Eastern Extension, the Western and Brazilian, the Direct Spanish, and other telegraph companies.

A very full description of this Protector was given by Mr. Jamieson, in a Paper read by him before the Society of Telegraph Engineers, at their meeting in November, 1876, to which we sent specimens (see *Proceedings* of this Society, Vol. V., pages 358 to 388, with a full sized drawing of the pattern we make specially for submarine cables).

We herewith enclose a tracing of this drawing (see Figs. 1 and 2), which we are not aware has been otherwise illustrated except in Wunschendorff's "Submarine Telegraphy" of 1888.

"Jamieson's Lightning Protector" combines three things in direct circuit with landline and cable or landline and telegraph instrument:—

(1). The fine points between line and earth plates or cross serrated cylinders.

(2.) Two or more straight fine platinum wires, which automatically come into circuit, the one after the other (so as to keep up telegraphic communication), until the last one fuses or the fine-covered wire coil gives way.

(3.) A fine-covered wire coil brought into intimate association with the earthed cylinder by being wound round the same (just as in Mr. Bennet's proposed plan), so that the self-induction of this coil may, as far as possible, assist in protecting the telegraph instrument or the cable from injury should (1) the points and (2) the fine platinum wire have failed to do so.

We have never had any report that this protector failed in its duty, but we would like to have Dr. Lodge's opinion upon this combination of points, wire, and coil.—Yours, &c.,

LATIMER CLARK, MUIRHEAD, AND CO. (Limited).

23, Regency-street, Westminster, S.W., Aug. 21, 1889.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The short article in your issue of 16th August on "An Improved Lightning Protector," might, I think, admit of a little discussion.

In the first place the writer announces that "experience shows that fusion of coils of fine wire by lightning almost invariably occurs at the commencement of the winding . . . penetration beyond the first layer appears to be altogether unknown." This may be the happy experience of the writer, but it is not the experience of a practical mechanic who for many years has had the repairing of many and various kinds of fine wire coils and of all kinds of lightning protectors. He has in most cases found the damage to have taken place in the layer next the iron core of the relay or the earthed metal core of the lightning protector, and in some few cases fusion has taken place near the middle of the coil, but *never* at the commencement of the winding.

The "improved" protector which the writer submits, is simply the discarded bobbin protector of the Post Office combined with the more or less generally discarded serrated plate protector, the former having been discarded, not because it "always" pro-

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The best for overhead Telephone and Telegraph Lines,
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Hard Drawn High Conductivity Copper Wire.
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PHOSPHOR BRONZE.
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tected, but because it always broke down the circuit; and the latter, because it was found not to be so efficient as the plain plate protector. For one thing, the serrated protector must be carefully protected from dust; whereas the plain plate protector with thin mica sheet needs no protection.

Again, the replacing of the damaged coil, although simple enough in itself, would be too much for unskilled hands, and I expect telephone inspectors or linemen would be kept busy replacing them after a thunderstorm, as telegraph linemen were in the days when the Post Office used the bobbin protector.

The writer must refer to the telephone world when he says that the arrangement he proposes is novel. Cables in the Post Office service, and I expect in most cable companies, are, and have been, protected for a long time by a combination of, firstly, a plate protector; secondly, "the intimate association of fine wire with an earth plate;" thirdly, a vacuum tube; and lastly, next the cable a short piece of very fine platinum wire.—Yours, &c.,

W. NOBLE.

Postal Telegraphs, Aberdeen, August 20, 1889.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

August 6, 1889.

12,374. J. F. BENNETT. Sheffield. Improvements in magnets.
12,378. J. E. STOREY. Manchester. Electric drills.
12,389. E. J. HOUGHTON. Dulwich. Current reverser for train-lighting purposes.
12,390. S. C. C. CURRIE. Birmingham. Improvements in electric motors.
12,389. E. J. HOUGHTON. Dulwich. An electrical contact maker and current diminisher for train-lighting purposes.
12,402. W. P. KOOKOGEY. Glasgow. A galvanic battery solution.
12,418. A. J. BOULT. London. Improvements in or relating to the manufacture of insulating tubing for electric conducting wires (H. B. Cobb, United States).
12,436. H. J. SMITH. London. Improvements in magnetic-electric machines.
12,437. F. W. FLINT. London. Improvements in electric drinking vessels.
12,444. J. R. SMITH. London. Improvements in switch boards for telephone systems.

August 7, 1889.

12,474. H. W. BISHOP and F. BROWN. Walsall. The inlaying of metals by electro deposition.
12,503. F. V. ANDERSEN. London. Improvements in dynamo-electric machines.
12,518. T. COAD. London. Improvements in incandescent electric lamps.

August 8, 1889.

12,552. J. H. BARRY and G. B. LÜCKHOFF. London. A novel construction or arrangement of electro-motor.
12,563. R. M. LOWNE. London. Improvements in electrical ships' logs or means for ascertaining by electricity the speed of ships.

August 9, 1889.

12,569. R. BELLFIELD. Liverpool. Improvements in plates for electrical transformers.
12,619. F. J. PATTEN. London. Improvements in and relating to dynamo electric machines or motors.

NEW COMPANIES REGISTERED.

JOHANNESBURG ELECTRICITY SUPPLY COMPANY (LIMITED).—Registered by Hollams, Sons, Coward and Hawkesley, with a capital of £250,000 in £1 shares. Object, to acquire and take over a concession dated February 28, 1889, in relation to the supply of electric light in Johannesburg and its suburbs, granted by the Government of the South African Republic, and to work and turn the same to account, and to carry on the business of an electric supply company generally. There shall not be less than three nor more than seven directors. The first are Sir Charles Metcalfe, Bart., Sir Douglas Fox, F. Henwood, A. P. Matheson and Colonel R. Thynne, C.B. Qualification £100. Remuneration, £2,000 divisible.

CITY NOTES, &c.

CHILI TELEPHONE COMPANY (LIMITED).—A prospectus of this company was issued last week. The capital of the company is £250,000, divided into 50,000 shares of £5 each. The directors are:—R. Raynsford Jackson, Esq. (National Telephone Company, Limited), chairman; Hon. F. Ernest Allsopp, 12, New Cavendish-street, W.; T. Greenwood, Esq. (Taltal (Chili) Railway Company, Limited). Bankers: Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, E.C. The secretary (*pro tem.*) is Mr. Edmund Petley, and the offices are situatate 53, New Broad-steet, E.C. The prospectus states that the company has been formed for the purpose of acquiring and extending the property and business, in the Republic of Chili, of the West Coast Telephone Company, which is an American Corporation.

DEVON AND CORNWALL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—With the sanction of Mr. Justice Chitty a third and final return of capital, amounting to 3s. 4½d. per share, has been declared by Mr. H. T. Edwards, the official liquidator of this company, and is payable to the shareholders on any Monday at the offices of Messrs. James and Edwards, 66, Coleman-street, London, E C.

DISSOLUTION OF PARTNERSHIP.—The partnership between Mr. F. C. Phillips and Mr. F. G. Hart, trading as electrical engineers at 2, Victoria-mansions, Westminster, S.W, under the title of Phillips and Hart, has been dissolved.

FALCON ENGINE AND CAR WORKS.—An extraordinary general meeting of the shareholders of this company was held on Thursday last week at the offices, 39, Coleman-street, E.C., for the purpose of confirming resolutions passed on the 23rd ultimo, approving of the provisional agreement between the Falcon Car Company and a trustee for the company intended to be formed, to be called the Brush Electrical Engineering Company, for winding-up the company, and authorising the liquidators to carry into effect the agreement. Mr. Aymor H. Sanderson, who presided, formally moved the adoption of the resolutions. This was seconded by Mr. Duncan, and agreed to.

THE FOWLER-WARING CABLES COMPANY (LIMITED).—We are informed that the capital of this company was largely over-subscribed. Letters of allotment and regret have been posted.

THE MANGANESE BRONZE AND BRASS COMPANY.—At the ordinary general meeting of this company, held on Thursday last week, the directors proposed to pay a further dividend of 10s. per share, free of income tax, payable on 2nd September next, making, with the interim dividend paid in March last, 16s. per share for the year, and carrying forward £1,759.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended August 16, 1889, amounted to £4,334.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 16, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,935.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this company for the half-month ending August 15 amounted to £2,784, as compared with £2,629 in the corresponding period last year, a decrease of £245.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

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This new material is supplied in two qualities, Flexible and Hard.

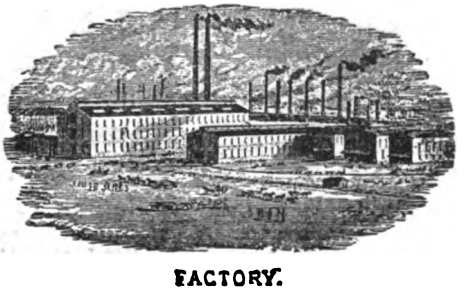
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Aug. 21, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Aug. 21, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	3%	Anglo-American	52 53	4 14 4	Jan., Apr., July, Oct.	52¼	52⅛
2,614,820	Stock	6%	Do. Preferred	88½ 89½	4 7 7	,, ,,	89⅛	88⅝
2,614,820	Stock	...	Do. Deferred	17½ 18¼	...	February	...	...
130,000	£10	10%	Brazilian Submarine	12¾ 13¼	6 0 9	Mar., June, Oct., Dec.	13⅛	13
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9%	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10%	Do. Preference 10%	20 21	4 17 6	,, ,,	20	...
12,931	5	10%	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	...	...
6,000	5	10%	Do. Preference 10%	8½ 9½	5 5 3	April and October	...	...
60,710	20	3⅛%	Direct United States	10½ 10⅞	5 16 2	Jan., Apr., July, Oct.	10⅞	10⅛
380,000	10	11 0	Eastern	13⅜ 13⅝	4 15 5	,, ,,	13⅝	13⅜
70,000	10	6%	Do. 6 per Cent. Preference	15¼ 15⅝	3 16 2	,, ,,	15⅝	15½
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109½	108⅝
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	108 109	4 10 1	February & August	107⅝	...
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13 1/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	105 106	4 14 4	January and July	...	...
179,177	10	8%	Globe Telegraph and Trust	8⅜ 8⅝	8 7 3	Jan., Apr., July, Oct.	8⅝	8 7/16
178,992	10	6%	Do. 6 per Cent. Preference	14⅜ 15⅛	3 19 4	,, ,,	15	14 13/16
150,000	10	7½% for '88	Great Northern	14⅝ 15⅛	4 12 4	Jan., July, and April	15 5/16	14⅛
17,000	25	15%	Indo-European	40 42	6 1 6	April and October	41½	...
9,000	8	5%	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	9⅜	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
80,000	10	6% for '88	West Coast of America	10 10½	5 14 3	January and July	10⅜	10
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	2⅜	...
34,563	10	12/0*	Do. 1st Preference 6%	11⅞ 12¼	...	April and October	12¼	12
4,669	10	†	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	6%	Western Brazilian	10¾ 11¼	6 10 4	March & September	11	...
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅞ 1	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	4 8 3	...	...	...
55,000	5	3/0	United River Plate	5¼ 5⅜	...	January and July	5⅛	...
			ELECTRIC LIGHT.					
23,003	5	...	Anglo-American Brush (£4 paid)	3⅛ 3⅜	...	...	...	...
23,692	5	...	Do. (fully paid)	4⅛ 4⅜	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	4⅛ 4⅜	...	...	4 5/16	4¼
			MISCELLANEOUS.					
37,350	12	10%	Telegraph Construction and Maintenance	43 45	5 6 3	March and July	45	44
41,600	10	10%	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19¾	...

* Account arrears. † No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 589.—Vol. XXIII. FRIDAY, AUGUST 30, 1889. Price Fourpence.

NOTES.

Nothing could have been more completely *apropos* or in better taste that the eulogy delivered by Sir William Thomson upon the work of the French electricians at the joint meeting of the Société International and our own Institution on Friday last. Sir William's own scientific methods are, indeed, widely different from those which characterise the French school of theorists, but his and our appreciation of their numerous triumphs is, doubtless, none the less thorough and sincere on that account. We none the less venture, in the interest of historical accuracy—and we think we need make no apology for so doing—to demur to one or two of the admissions which the President made in respect of French claims to priority in invention. Surely it is scarcely correct to say that Gramme was the first to construct a practical dynamo machine. Was not Gramme at the very time of his great invention of the armature that bears his name in the service of the Alliance Company? And was not this company then building the Wild machine—a machine which was so far practical that it had been adopted by the Trinity Board? To Gramme was due the epoch-making invention of an armature capable of yielding a quasi-continuous current, but there were practicable dynamos before his day. Again, Sir William yields to Duboscq the credit of having constructed the first automatic arc lamp, an honour which is generally conceded to Staite. Indeed, Prof. S. P. Thompson has, we believe, discovered that Duboscq's first specification for a patent was rejected on the ground of anticipation by Staite. To Davey and to Faraday the world owes the discovery of the principle of the arc light and of the dynamo, and if, as we honestly believe, to our countrymen also belongs the honour of first bringing these great discoveries into the region of practical utility, we cannot consent to lightly yield the claim.

The tenth meeting of the National Electric Light Association, at Niagara Falls, appears to have been of the usual successful character. The Papers, however, do not possess so much interest for English readers as those read at the last summer meeting. A considerable amount of time was devoted to the subject of execution by electricity, and the outcome of Mr. F. A. Wyman's legal memoir, and the subsequent lengthy discussion thereon, was a decision to petition against the new law to the General Assembly of New York, and a general protest against this "unnecessary degradation of the most useful natural agent that science has ever rendered available for the service of man."

In Mr. G. W. Mansfield's Paper on "Electric Railways," which we print elsewhere, there are some striking figures illustrating the very marked effect which the number of cars operated, gradients, and other local circumstances have upon the electrical horse-power required per car. Thus at Boston, Mass., the average electrical horse-power per car is 5·9, while at Richmond, Va., it is between 4 and 5, and at Lafayette only 2·5 according to Dr. Bell.

Our reply to Mr. Swinburne's further letter will be but brief, though we shall endeavour to make it clear. Our correspondent devotes the first portion of his letter to anathematising those people who misuse the term "self-induction," and in this we can most heartily concur, since our own conscience is absolutely clear. But with a degree of inconsistency which we are wholly at a loss to explain, Mr. Swinburne permits himself, in a succeeding paragraph, to employ the term to describe the reaction of the armature upon the (separately excited) field; this is, of course, a case of *mutual*, not self, induction. The issue is in this way somewhat obscured, but we think it can be made tolerably clear if we restate our own view in few words. Let there be an alternator driving a synchronising motor. Now, if the latter tend to get out of step the virtual current (as Mr. Swinburne calls it) immediately rises, thus increasing for the while the torque upon the armature of the motor. But the couple producing the torque is due to the reaction between the magnetic field of the armature and that of the field magnets. *Mr. Swinburne calls this the self-induction of the armature.* On the contrary, following orthodox usage, we have always spoken of the self-induction (or, to be more exact, the E.M.F. of self-induction) as being due solely to the change of current in the armature, being of course proportionate to the *rate of change*, and tending to oppose and delay such change. Hence we conceive Mr. Mordey to be wholly in the right when he says that the less the total self-induction in the circuit, the more perfectly will synchronism be maintained, because the more rapid will be the rise of current necessary to increase the torque and pull the armature of the motor into its proper position.

From what has just been said it is easy to deduce the corollary that the stronger the field of the motor the less will be the

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energy wasted in maintaining synchronism. (This, by-the-bye, is the criterion by which we judge whether a machine will synchronise "equally well" under varying conditions. We mention it because Mr. SWINBURNE complains, perhaps justifiably, that "equally well" is a vague and unscientific expression.) The corollary above stated has been justified by experiment upon the Mordey alternator. Mr. SWINBURNE, upon the other hand, asserts that "an ordinary motor can be made to work well at full load *by weakening the field* till it is cophasedly synchronised." This is a result which, from the considerations which have just been advanced we should certainly not have anticipated. If, therefore, our correspondent is speaking from actual experimental knowledge, we must beg him to note that his result is not one upon which any general law can be based, unless he is first prepared to show why the Mordey alternator should prove an exception to the rule. This, however, is not the only statement made by our correspondent upon which the evidence in our possession leads directly to the contrary conclusion. To take one more instance only—but a quite fundamental one—Mr. SWINBURNE remarks that "the armature loss will increase as the load is decreased," and adds, "it is here that, I take it, I differ from Mr. MORDEY and from you." Certainly he does. We are also puzzled by our correspondent's statement that a machine can be run with the same field strength, first at 1,000 revolutions and next at 500 revolutions, and yet give the same number of volts. It would, we are sure, be instructive to learn how this is done.

SEEING, however, that we are so little agreed as to the data upon which the discussion is or should be based, it is manifestly useless to pursue the argument further. Our own position is, in fact, a little anomalous. Mr. SWINBURNE, it will be remembered, first drew the sword on us, and in defence we made use of certain experimental data, which, by the courtesy of Mr. MORDEY, have been placed in our possession, but which, pending the completion of the experiments, Mr. MORDEY does not wish to be fully made known. When we add that we have this week found it necessary to remove our editorial chair to the banks of the Seine, our motives for declining further controversy, at least for the present, will be readily understood. At an early date we hope, however, to see the combat renewed in more regular form, and with, we trust, some quite decisive result.

THE withdrawal of a large number of experienced telegraphists from the British Telegraph Service for employment in the Colonies and elsewhere seems to have given rise to some inconvenience at a few of the large provincial offices, notably at Cardiff, where, among other grievances now being aired in the Western newspapers, the staff are said to be suffering from overwork and incompetent juniors. If we may believe half of what we read, the public also are aggrieved by this state of affairs, and attention has already been drawn to the subject in Parliament. It is not denied that the clerks themselves are furnishing the material for these comments, and the reflection occurs to us why do they not agitate for the transfer of skilled operators from minor offices to fill the vacant posts? This, or the training of learners on the spot, is obviously the only means available for the purpose. We have noticed lately a praiseworthy move in the former direction as regards Postmasterships and the superintendents of Telegraph offices. There is really no reason why the same policy should not be pursued in the promotion of junior telegraphists—unless it be the objection of the local staff to have outsiders brought in from other offices.

ON the strength of the discovery that Postal and Telegraph profits combined yield a profit of nearly £4,000,000, Mr. HENNIKER HEATON urges his contention through the columns of *The Times* that all future profits in excess of this amount should be devoted to cheapening and facilitating postal and telegraph communication. As regards the Post Office, we need not stop to argue with him whether or not that department has a right to make a profit; for as it is the public, and not the department, that pockets the surplus, the public alone is entitled to spend it. But in respect to the Telegraph service, any disposal of its profits in the way suggested ought on strict business principles to be postponed for many years to come, seeing that the Telegraphs have been working at a loss for nearly twenty years past. When prospective profits have covered the accumulated deficits, we may then reasonably talk of lowering the rates. Meanwhile they are cheap enough for everybody but Mr. HENNIKER HEATON.

IN a recent number of the *Revue d'Hygiène*, M. MAKLOKOFF, of Moscow, relates his experiences of an "electric sunstroke" received at the Benardos Electric Welding Works at Kolomno, near Moscow, where it seems there is great difficulty in getting the workmen to work more than two hours a day, although they are paid very highly, on account of the injurious effect of the arc. The current at the Kolomno Works is obtained from 500 Planté accumulators, and an arc 5 centimetres long is produced. In order to obtain personal experience of the effects of an "electric sunstroke," and to be in better position to suggest a remedy, M. MAKLOKOFF exposed himself for about ten minutes to the light of the naked arc at close quarters. The outcome of this *experimentum in corpore vili* was, as will be seen, somewhat unpleasant. Two hours later a tingling sensation, combined with burning of the eyes and skin, was experienced. This was followed by a cold in the head and watering of the eyes, tumefaction, discoloration of the skin of the face, neck, and hands, chemosis of the eyelids, and photophobia. A feverish night. The following day increasing œdema. On the third day there was a deepening in the brickdust colour of the skin, which commenced to crack and peel. The chemosis and pains in the eyes disappeared when a secretion in the conjunctiva began to show itself. Subsequently there was desquamation of the skin, as in erysipelas. M. MAKLOKOFF attributes all these effects to the chemical action of the rays, and suggests that a glazed taffety veil, placed on a wicker headpiece, and provided with grey glass eyelet-holes, should be worn by those employed in the Benardos process and analogous operations.

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The Metropolitan Electric Supply Bill.—The Royal assent to this Bill was given on Monday last.

Farnworth.—The Farnworth Local Board have instructed their Clerk to ascertain what steps should be taken by them in applying for an electric lighting Provisional Order.

Valencia.—Tenders have been invited in the Spanish papers for the electric lighting of Valencia. As the tenders have all to be in by the end of the present month, foreign competitors are practically excluded.

Bradford.—The New Midland Railway Station and Hotel, which are to be opened about the end of September, will be lighted by the electric light. The installation is being carried out by Mr. Langdon, the company's telegraph engineer.

The British Association.—The University of Durham has decided to confer honorary degrees upon several of the most noted members of the British Association during the visit of the latter to the north next month. The degrees will be confirmed at a special convocation.

The Electric Light at Rufford Abbey.—Lord Savile has had Rufford Abbey lighted throughout with the electric light, which has been introduced into every portion of the abbey, 400 lights, run off accumulators, being required. The whole of the work has been carried out by Messrs. Edmundsons, of Westminster.

Tenders for Telephone.—The Madrid *Gazette* contains a notice inviting tenders for the 30th proximo for the establishment and working of a telephone system in the island of Puerto Rico. The conditions provide for the payment to the Government of 6 per cent. of the total receipts.

A Magnet for Extracting Iron Filings.—Messrs. Frister and Rossmann, of Berlin, are making very powerful little magnets for the special purpose of extracting iron and steel filings from the eyes and skin of workmen engaged in ironworks. These magnets are of the horse-shoe shape, nickel-plated, with thin rounded poles, only a few millimetres thick.

The Lighting of Madrid.—The *Industria é Invencimes* says that a proposal for lighting Madrid with the electric light has been submitted to the Ayuntamiento by Señor Luis Capiston, in the name of the International Society for Lighting by Electricity. Señor Capiston offers to make a deposit of 100,000 pesetas, say £4,000, as guarantee for the due fulfilment of his offer.

Melbourne.—Although the evidence of experts at the recent inquiry into the cause of the destruction of the Bijou Theatre by fire discredited the idea that the electric lighting had anything to do with it, yet there seems, according to the local papers, to be a general desire that a public officer should be appointed to inspect all indoor installations before they are used.

Nantua.—A central lighting station was inaugurated at Nantua (Ain) last month, the motive power of which is obtained from a 40 horse-power turbine, driven by a 14ft. waterfall. The four dynamos are shunt-wound Gramme machines, giving 120 volts and 110 amperes. The three-wire system, with feeders, is employed, and the conductors are all run overhead.

Macclesfield.—At the last meeting of the Macclesfield Gas Committee, the Town Clerk submitted notices from two companies of their intention to apply for Provisional Orders for the supply of electric lighting in the borough. It was resolved that a special meeting be called to consider the advisability of the Corporation applying for a Provisional Order to supply electric lighting.

Huddersfield.—At a meeting of the Town Council on Wednesday last week it was resolved to make application to the Board of Trade for a Provisional Order giving power to the Corporation to provide and supply electricity within the borough. The Yorkshire House-to-House Electricity Company has announced its intention of applying for a Provisional Order for this town.

The Edinburgh Exhibition.—A deputation from the Executive Council of the Exhibition is at present in Paris, and arrangements have been made for the transmission to Edinburgh of a number of exhibits in the Exposition Universelle. Mr. Edison has been interviewed, and expressed himself much interested in the Exhibition, and he has consented to act as one of the vice-presidents.

Electric Light on the Midland Railway.—For some months past several of the Midland Railway Company's trains between St. Pancras and Manchester have been furnished with the electric light. After a lengthened trial, during which the great improvement in the ordinary train light has been made manifest, the company have decided to extend the light to their local trains. Already one or two experiments have been made in carriages running between Manchester and Stockport.

Sales by Auction.—The sale of the business of the Jensen Electric Bell and Signal Company, which was announced in our last issue, is fixed for Wednesday next. Messrs. Wheatley Kirk, Price and Goulty are also instructed to sell early in September the business of Mr. Lawrence Oppermann, of the Crown Works, Amhurst-road, Hackney. The sale by auction of the plant of the Basingstoke Iron Works, is also announced by Mr. Davison. Full particulars of these sales will be found in our advertisement columns.

An Electric Light Inspector for Liverpool.—The Watch Committee of the City Council had before them on Tuesday the seven selected candidates for the new office of electric light inspector for the city. Owing to the fact that there were no less than 47 applicants the matter has taken some time to settle. The Committee decided to recommend the Council to appoint Mr. C. H. Yeaman, assistant electrician to the Ward Electrical Car Company, London. The salary attached to the office is £160 per annum.

The Belgrano (Buenos Ayres) Gas Bill.—This Bill, to which we referred in our issue of July 19th, received the Royal Assent on Wednesday. The Chairman of Committees in the House of Lords had some difficulty about altering the memorandum of the company so as to enable it to embark on a business, namely, electric lighting, totally distinct from that for which it was originally incorporated. In order to have the matter thoroughly sifted, a Committee of members of both Houses was appointed, and the difficulty was overcome.

Friern Barnet.—At a recent meeting of the Friern Barnet Local Board, a report was presented in reference to the question of electric lighting of the district. It stated that a communication had been received from an electric light company who were prepared to light the district with 28 lamps of 43 candle-power, at a charge of £5 per annum for each lamp; the cost of erecting the necessary machinery and appliances being £1,360. The expense of running the cable underground would be £200 more, the length of the cable being 1½ miles.

Newcastle.—The Newcastle and District Electric Lighting Company and the Newcastle Electric Light Supply Company have received intimation that the terms of their license for lighting Newcastle have now been practically settled with the Board of Trade. The companies therefore expect to be in a position to commence the laying of the main cables almost immediately. The machinery and plant are now well advanced, and the companies intend to push forward the work of laying the cables vigorously so as to be able to supply current to customers before the end of next month.

Proposed Electric Railroad between Lanark and Hamilton. It is stated that a private company has been formed with the intention of constructing an electric railway from the town of Lanark to Hamilton, along the valley of the Clyde, the motive power to be obtained from Stonebyres Linn, one of the series of the Falls of Clyde. This is the broadest and most powerful of the Falls, the descent being nearly 80ft. The object is to afford the people of Lanark a more direct journey to Glasgow *vid* Hamilton than by way of Carstairs Junction. The distance between Lanark and Hamilton is about 15 miles.

Mr. Edison in Paris.—Mr. Edison was entertained on Thursday evening last week at the Hôtel Continental at a banquet given in his honour by the directors of the Compagnie Continentale Edison. Among the guests invited were Mr. Whitelaw Reid, United States Minister, M. Tirard, M. Janssen, of the Institute, the Postmaster-General, MM. Antonin Proust, and Jules Claretie. On Monday Mr. Edison was entertained by the *Figaro*, and on Tuesday evening, as will be seen in our Con-

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gress Notes, a reception was given in his honour at the Exhibition by the British Commissioners.

Bishop Stortford.—At the last meeting of the Local Board three tenders were received for lighting the town, viz., Defries Oil Lamp Company, the Bishop Stortford Gas Company, and the Laing, Wharton and Down Construction Syndicate. The Gas Company tendered at £3. 5s. per lamp per annum. The Electric Light Company were willing to enter into a five years' contract to light 220 lamps of 20 candle-power each at a cost of £770 per annum, or £3. 10s. per lamp. A long discussion took place on the subject, and eventually it was decided to accept the Gas Company's tender.

Montreal.—On the first of August the streets of Montreal were for the first time wholly lighted by electricity. The Royal Electric Light Company fulfilled the terms of their contract, and 753 arc and 346 incandescent lights were lighted all over the city from shortly after eight p.m. to daybreak. The light has given general satisfaction, although the distribution of the lamps has been the cause of several complaints. In order to avoid as much as possible complaints about lights being out, 14 men (six on foot and eight on horseback) have had districts assigned them, so that in case of a lamp failing to burn it may be attended to as speedily as possible.

A Monster Casting.—An unusually large casting took place at Messrs. Wm. Beardmore and Co.'s Parkhead Forge on Friday afternoon last. Over 70 tons of metal was run into a mould sunk 23ft. into the ground, to form a shaft for a dynamo being constructed for the London Electric Supply Corporation. The casting is of Siemen's steel, and when cold will be hollowed to a diameter of 12in. When finished it will weigh about 32 tons. This is the second shaft cast by the Messrs. Beardmore for the London Electric Supply Corporation, and they have a third still to supply. The casting was in every way successful, and a shaft of excellent quality is expected.

A New Method of Preparing Wooden Battery Boxes.—It has long been a subject of complaint with regard to wooden battery boxes, says *La Lumière Electrique*, that in spite of internal and external coats of varnish they always begin to warp and leak after a certain time. With a view of remedying this defect the following process has been recently tried, it is said, with very satisfactory results :—The boxes are dried and placed in a closed vessel, which is then exhausted. The protecting liquid is next allowed to run in, and when the boxes are well covered air is admitted, and the pressure of the atmosphere drives the varnish right into the pores of the wood, rendering it highly impermeable.

New Books.—Messrs. J. and A. Churchill announce that they will publish in September an important work on Fuel and its Applications, by Mr. E. J. Mills, F.R.S., and Mr. F. J. Rowan. It will be the first volume of a large work on Chemical Technology of which Mr. C. E. Groves, F.R.S., will be the general editor, and which will be founded on one written by Richardson and Ronalds, familiarly known as "Knapp's Technology." Messrs. Mills and Rowan's work on fuel is in reality a new work, in which the applications of fuel to arts and manufactures as introduced by the most modern discoveries is given to the scientific world. The volume is profusely illustrated.

A Cable between Guatemala and the United States.—According to the *Revista Telegrafica*, the Government of Guatemala has concluded an agreement with Mr. McNider, for the establishment of several submarine cables between that country and the Antilles, Venezuela and the United States. The cables are to be in working order within two years' time, and an annual revenue of £5,000 is guaranteed by the Government. Official messages are to be transmitted at a reduction of 33 per cent. upon the ordinary tariff, and the contractor has bound himself to supply the Government of Guatemala with a daily *résumé* of all foreign news of importance for the sum of £20 a month. The tribunals of the Republic of Guatemala will alone be competent to adjudicate upon any differences that may arise between the contractor and the Government.

Obituary.—Prof. Elias Loomis, whose death is announced from New York, was one of the most distinguished physicists of the United States. He was born at Wellington, Connecticut, in 1811, and was educated at Yale College. In 1834 Prof. Loomis made hourly observations for sixteen hours per day, extending over fourteen months, of the declination of the magnetic needle. In 1836-7 he spent a year in Paris attending the lectures of Arago, Biot, and others. On his return he became Professor of Mathematics and Natural Philosophy in Western Reserve College, Ohio, where he remained until 1844. He also observed the dip of the magnetic needle at over 70 stations spread over 13 States, and extending from the Atlantic to the Mississippi River. In 1844 he became Professor of Natural Philosophy in the University of the City of New York, which chair he continued to fill until 1860. He then became Professor of Natural Philosophy and Astronomy in Yale, which appointment he held until his death. Prof. Loomis was the author of a series of mathematical and scientific text books, of which more than 500,000 copies were sold, and some of which have been translated into Chinese and Arabic.

Non-Magnetisable Alloys.—C. A. Paillard has recently drawn attention to the valuable properties of some of the alloys of palladium, and advocates their use in the manufacture of non-magnetisable watches. The composition of four alloys has been ascertained, and the author has examined their respective properties. An alloy consisting of palladium 60-75, copper 15-25, and iron 1-5 per cent., is really formed by mixing half the palladium with the copper and iron, and fusing the mixture with borax and powdered charcoal. The remaining palladium is then added, and the alloy fused and poured into moulds. A cheaper alloy, containing palladium 50-75, copper 20-30, and iron 5-20 parts, is recommended for common watches and certain parts of the works. An alloy similar in composition to the former, but containing 3-10 of silver and 1-5 per cent. nickel, with a small percentage of gold and platinum, is not affected by atmospheric changes, and its elasticity is not influenced by temperature. This alloy is also less magnetic than the two described above. If the percentage of silver be increased, and a corresponding diminution in the amount of palladium to 45-50 per cent. be made, a very good alloy is obtained, which is especially characterised by its great hardness.

Life of Arc Light Carbons.—In an interesting thesis on the length of life of arc-light carbons, contributed to the organ of the Cornell University, Mr. Louis B. Marks says :—The question has been asked in what manner and to what extent the size of the carbon affects the result in a current of given strength, covering, of course, in the general question of conductivity, the all-important results of light and life? The conclusion is now drawn from a multitude of experiments that, with carbons of the same manufacture and type, the life of the carbon varies directly with its diameter and inversely with its resistance. Thus the life of a 1in. brush carbon having an actual diameter of ·986in. and a resistance of ·061 ohm is, according to test, 26·15 hours. According to the law above stated, the life of a $\frac{5}{8}$in. brush carbon having an actual diameter of ·618in. and a resistance of ·0735 ohm would be by calculation 13·62 hours. When put to test this carbon burned 13·64 hours. Those systems in which a small current and a long arc are used are considered as high-tension systems, and those in which a large current and a short arc are used as low-tension systems. It has been found that, generally speaking, a moulded carbon is superior for high-tension and a forced carbon for low-tension systems.

Telegraphic and Telephonic Statistics.—According to a recent note in our well-informed contemporary, *La Lumière Electrique*, the total length of the telegraph lines of the world amounts to 557,064 miles, made up as follows :—Europe 216,490 miles, America 163,642 miles, Asia 46,800 miles, Australasia 24,204 miles, Africa 12,060 miles. To these must be added 950 submarine cables, 774 of which are laid in European seas, and have a total length of 3,200 miles, while the remaining 176, with a length of cable of 85,850 miles, belong to companies. The service of these lines is carried out by 160,000 offices. The telephonic statistics of the various countries of the world are as follows :—The United States 739 exchanges and 158,712 subscribers, Germany 164 exchanges and 31,325 subscribers, England 122 exchanges and 20,420 subscribers, Sweden 137 exchanges and 12,864 sub

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scribers, France 28 exchanges and 9,487 subscribers, Switzerland 71 exchanges and 7,626 subscribers, Russia 36 exchanges and 7,589 subscribers, Italy 28 exchanges and 6,183 subscribers, Belgium 4,674 subscribers, Austro-Hungary 4,200 subscribers, Norway 21 exchanges and 3,930 subscribers, Holland 9 exchanges and 2,872 subscribers, Spain 2,218 subscribers, Denmark 1,837 subscribers, Portugal 2 exchanges and 890 subscribers. The town with the largest number of subscribers is Berlin, with upwards of 10,000, followed by New York, which has 6,900, Paris with over 5,000 and London with just that number.

Leicester.—At the meeting of Leicester Town Council on Tuesday, the Gas Committee recommended the Council to apply for a Provisional Order authorising the Corporation to supply electricity for public and private purposes within the borough. Councillor Lennard, in moving the adoption of the report, said that four companies had given notice of their intention to apply to the Board of Trade for an Order to supply the town. The Gas Committee had to consider what was the best thing to do for the town. It would not be right that they, as the lighting authority, should put themselves in the path of progress. Three courses were open to them. They might have selected any one of the companies, and have consented to an Order being granted to it. They might have opposed the application, or they might take powers themselves. With a view of preventing the monopoly of a single company or the friction which would be certain to arise between two or more companies, the Gas Committee finally decided to recommend that the Corporation should obtain powers. Mr. Lennard then detailed the courses open to them after the Order was obtained, and contended that if they acquired the right themselves they would get better terms out of the rival companies, if they felt inclined to trust the work to one of them, than if they allowed the companies to get the Order themselves. But the best thing for the public in the long run would be that the Corporation should work the whole affair themselves. They were not acting in a "dog-in the-manger" spirit, but *bonâ fide*. Mr. Lennard concluded by expressing a hope that they would not be unduly forced into producing electricity. The report was adopted *nem. con.*

Electricity from Heat.—In a thesis recently read at the Cornell University, Mr. G. D. Shepardson refers to the different methods for transforming the latent energy of fuel into electrical energy. The high efficiency of most electrical transforming devices and the ease of obtaining heat from electricity indicate, in his opinion, the possibility of some electrical method of getting cheap power from coal to excel the 10 per cent. efficiency of the steam-engine. The different methods fall into two general classes accordingly as they work by a changing temperature or by a constant difference of temperature in different parts. The first includes pyroelectric crystals, which are hardly adapted for commercial generation of electricity, and pyromagnetic motors and generators. A provisional theory for the latter gives a maximum thermodynamic efficiency of ·016 on one hypothesis, or of 0·000,000,005 on another, the former being the more probable. The second class is represented principally by the thermopile, whose efficiency is impaired by the conduction of heat from the hot to the cold junction, the highest theoretical efficiency for any combination yet tried being 0·12, while the highest actually attained and published is 0·0054. The thermopile is compared to a galvanic cell whose electrodes touch within the cell, the external effect being almost nullified by local action. Clamond has partially avoided this fault in recent types (1886), said to surpass all others in efficiency. By substituting an electrolyte for one metal of a thermopile, the efficiency is greatly increased and different gases have been introduced into the circuit with advantage. Attempts have been made, with indifferent success, to substitute carbon for the zinc of a galvanic cell, and to use the burning fuel as one electrode of a battery. One method uses the increased solvent power of liquids with rising temperatures. The most recent method is to increase the output of an alternating current transformer by heating the secondary coil. On the whole, the prospect is held by Mr. Shepardson to be encouraging as obtaining cheap power by the direct conversion of heat into electricity.

The Effect of Placing a Ball and Point in a High-Tension Alternating-Current Circuit.—A peculiar phenomenon which was first observed by Mr. E. G. Acheson has recently been investigated at the Cornell University. It bears a close relation to certain experiments of Mr. Wimshurst which will be within the recollection of our readers (see *The Electrician*, May 24, p. 70), and which was observed at a still earlier date by Faraday himself. The phenomenon referred to is as follows:—If a ball and a point be connected one to each pole of a source of alternating E.M.F., and also to the terminals of the galvanometer, a deflection as if from a direct current, will be observed in the galvanometer. It was found that, to get the effect, a high E.M.F. was necessary, and that the point must be brought so close to the ball that an arc forms between the two, and this arc drawn out to certain length, depending on the E.M.F. used, and on the resistance in the galvanometer circuit. The arc was shown to be intermittent, corresponding with the alternations, and to conduct apparently much more readily from the point to the ball than *vice versâ*, so that a very large excess of total current is in the direction from point to ball. A galvanometer placed directly in series with such a ball and point would show, therefore, a marked deflection. The currents used were very small. At present no exact ideas of their size can be given. Several sets of curves were obtained, showing the variations of E M.F. between ball and point, with small increments of time during a complete wave, both with and without the arc. They verified one another, and showed that as the point came to its highest positive potential the arc suddenly formed, and the potential difference between ball and point immediately dropped to a very low value, and remained there for about one-third of a complete wave, when the arc broke and the potential suddenly changed sign, jumping to its maximum value the other way. No arc forms from ball to point.

Zürich.—Ten firms have submitted tenders for the central station here, viz.:—Messrs. Crompton and Co., Chelmsford; J. Ehrenberg, Lucerne; Escher Wyss and Co., Zürich; the Uster Electrical Works; the Oerlikon Works; E. and P. Sée, Lille; Siemens and Halske, Berlin; Stirnemann and Weissenbach, of Zürich, representing Messrs. Ganz, Schuckert, and Sulzer; Thomson-Houston Company, Hamburg; and the Zürich Telephone Company. Six of the tenders were inadmissible because of their failure to comply with one or the other of the conditions originally laid down. The general programme laid down by the experts, says *Industries*, was based upon the employment of direct currents for the arc lights and alternating currents for the glow-lamps. The latter were to be fed by the least possible number of transformers, arranged in sub-stations, so that eventually, if reliable storage batteries should become available, the distribution of current to the glow-lamps could be on the direct-current system, in which case the alternators and transformers would have to be discarded. The project submitted by the Zürich Telephone Company, although the cheapest, was rejected because the arc lights were to be worked by alternating currents. Messrs. Siemens and Halske submitted two alternative schemes, one for alternating currents both for arc and glow-lights, and the other for direct currents on the five-wire system. The first was too expensive, and the second exceeded the limits of pressure fixed by the Commission. The project submitted by the representatives of Messrs. Ganz and Co. was based on parallel coupling of alternators; but the price was higher than that of the Oerlikon project, and the large number of small transformers distributed throughout the house was considered a serious drawback, not only for the present, but also because they made the future transition to the accumulator system more difficult. The Oerlikon project is based upon the use of direct currents for the arc lights, and alternating currents from large sub-station transformers for the glow-lamps. Each sub-station will contain one large and one small transformer, the first for the night and the latter for the day service. This arrangement has been adopted in order to minimise the loss of energy in magnetising the transformers when the demand for current is small. The Oerlikon tender has been accepted. The direct current dynamos will be of the Oerlikon type, and the alternators will be of the Kapp type.

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THE PARIS EXHIBITION.

The Exhibit of the Thomson Electric Welding Company.

The Exhibit of the Thomson Electric Welding Company occupies a part of the same stand as the Thomson-Houston Company. Four separate welding plants are shown, each of a different type and size, the largest being capable of welding wrought-iron bars up to 2in. in diameter, or pipes of 2½in. Power for working them is supplied by an Armington-Sims engine of 80 horse-power, placed in the centre of the stand. The dynamos are of the alternating type, already described in connection with the Thomson-Houston exhibit (see *Electrician*, August 16, p. 373), and, with the exception of the "self-contained" plant, are worked in conjunction with transformers in the usual way.

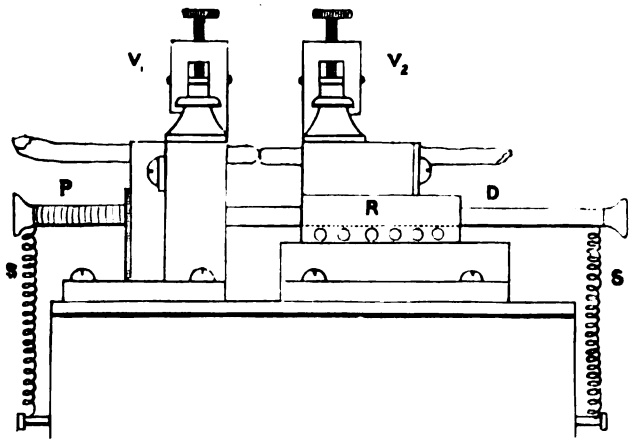

FIG. 1.—Thomson Automatic Electric Welder (Front View).

For the smallest work there is an automatic welder, provided with an arrangement by which the current is shut off when the weld is completed. Fig. 1 shows a front view, and Fig. 2 a side view of the apparatus. The clamps or vices V_1 and V_2, are mounted on a box containing the transformer, one of these, V_1, is fixed, the other, V_2, rests on small copper rollers, R, which allow free movement backwards and forwards, and at the same time keep good contact with the lower fixed portion; the vice V_2

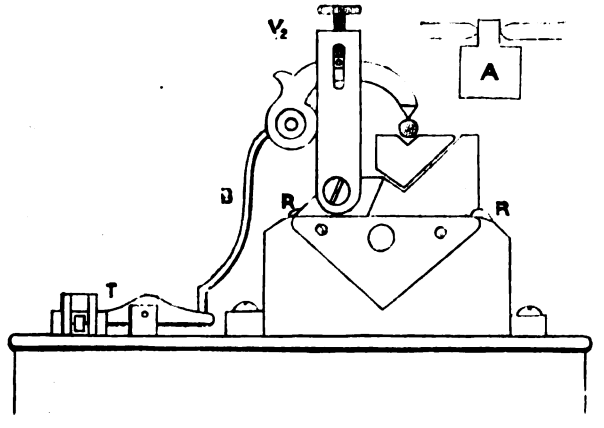

FIG. 2.—Thomson Automatic Electric Welder (Side View).

is held down by the springs S S, attached to the rod D, which passes through V_1 and is fixed to V_2. A small gauge, shown at A, Fig. 2, is slipped in between the clamps before the pieces of metal are made fast for the purpose of regulating the distance through which the sliding clamp travels before the current is turned off. The switch for effecting this is placed just behind the clamps (Fig. 2) and held back by a trigger, T, which is released by the pressure of a light adjustable arm, B, fixed to the moving clamp. When the two white hot ends of the pieces of metal to be joined have been sufficiently pressed together by the action of the spring P, the switch flies back and the primary circuit of the transformer is at once broken.

For regulating the strength of current supplied, Prof. Thomson has devised a "reactive" coil which is connected with the primary circuit in place of a resistance; it might be described as an adjustable "choking" coil. Its construction, which is quite simple, will be understood from Fig 3. A laminated iron ring, R, is fixed in a vertical position and wound over one-third of its circumference with wire P, which may be called the

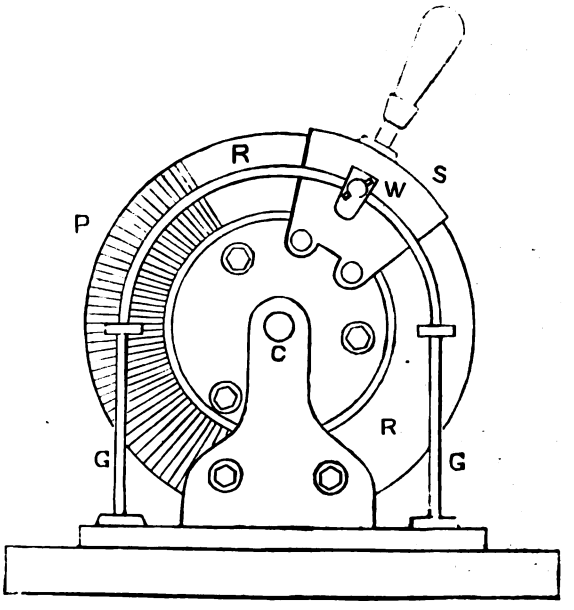

FIG. 3.—Reactive Coil.

primary coil, and through which the current from the dynamo passes. The centre is also filled with a laminated core moving on a spindle, C, and has a massive piece of copper S attached to it so as to surround the ring R. By means of the handle this can be turned over so as to envelop the coil P to any extent required, and its action is thus similar to a transformer with a movable secondary coil, the current in P increasing the more it is enclosed by the secondary S. By the aid of the clamping screw, W, and the guide rod G, it can, if necessary, be fixed in any position required.

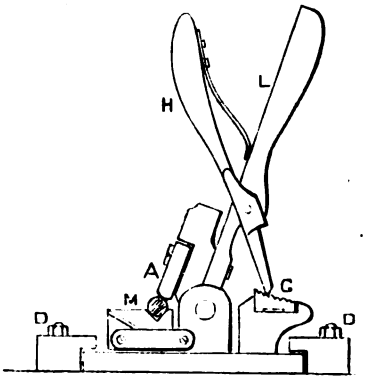

FIG. 4.—Electric Welding Clamp.

For welding iron up to ½in. in diameter a self-contained plant is exhibited. This is a most compact machine, and occupies a very small space. The bench for holding the clamps, switches, and adjustable resistance is supported above the dynamo itself by arms bolted on to the plummer block and pole-pieces. It is a two-pole machine of the motor type, with a drum armature wound with two sets of coils; one of them,

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for exciting the field, is connected to a commutator at the end of the hollow spindle, and the other set, consisting of a number of single turns all joined in parallel, is joined up to rings or collectors, from which the current is led away at once to the clamps on the table above. The strength of the current is regulated by an adjustable resistance in circuit with the exciting coils. One clamp is fixed, as in the plant described above, but the other works between guides (D D Fig. 4), and is controlled by a lever for pressing one up to the other while welding.

An indirect plant of a different type is shown capable of welding iron bars up to 1in. in diameter. The clamps are mounted on a box containing the transformer, for which power is obtained from a 4-pole alternator similar to one of those already described in the Thomson-Houston exhibit. The machine is self-exciting, there being two sets of coils on the armature, and it gives 70 amperes at a potential difference of 300 volts. The power for the automatic welder is also supplied from this machine.

The form of clamp used in this and the preceding plant is shown in Fig. 4, and is specially designed to avoid the waste of time that takes place where the pieces of metal have to be screwed down in a vice. The piece of metal M is held down by the clamp A attached to the lever L. By gripping the two lever handles H and L, and at the same time drawing L forward, the lower part of H catches in the rack G and holds it fast. The whole slides between the guides D D, and is worked to and fro by a lever, not shown in the figure.

The welding plant for the heaviest work consists of an exciter, a 6-pole alternating machine of the type already described, giving 38,000 watts at a potential difference of 300 volts, and of the welder with its transformer. The core of the transformer, which is about 15in. long, is built up of rings in the usual way, and wound with a primary coil, making 17 turns and consisting of large stranded wires capable of carrying 130 amperes. The secondary coil, which has one turn only, is made up of a thick copper tube, 4½in. in diameter, passing through the centre of the core and bolted to a massive piece of copper at each end that has a sectional area of about 20 square inches. The vice, which is fixed and insulated, is attached to one of these blocks of copper, and the other vice is in connection with the second block, thereby completing the circuit through the tube and the bars to be welded. Before fixing the pieces of metal into the clamp it is found to be an improvement to file away the edges into a slightly conical shape which has the effect of preventing the bulging that usually occurs at the joint; this must also have the effect of slightly increasing the heat at the ends, since the sectional area is thus diminished.

I saw Prof. Thomson weld together in this large machine two pieces of 2in. round iron in the presence of the jury, and the time needed to complete the joint was surprisingly short. Practical demonstrations are given every day by Mr. A. S. Garfield, the welding expert of the company. This exhibit should do much towards bringing the process under the notice not only of mechanical engineers, but also of ornamental metal workers, since it not only renders it possible to effect a good joint where the old process is inconvenient, but, as is already known, in the case of some metals and alloys, where soldering and brazing are both found to be almost, if not quite, impossible. Numerous specimens of work are shown, including welds in chains, twist drills, spanners, &c., by no means the most uninteresting being the words *Soudure electrique*, made up of pieces of all kinds of metals joined together and arranged on a board above the stand.

REVIEWS.

Modern Views of Electricity. By Prof. Oliver J. Lodge, D.Sc., LL.D. F.R.S. (London: Macmillan and Co. 1889.)

(Continued from page 400.)

Amongst other subjects which come within the purview of the new ideas of electricity as set forth by Prof. Lodge are the magnetic properties of matter. Electricity in rotation *is* magnetism according to the new doctrine; and the magnetic forces are simply the tensions and pressures set up in the medium as the result of vortex motion. It might have been wished that Prof. Lodge had dwelt at greater length upon the quasi-rigidity possessed by bodies in motion, and had further developed his ideas respecting the structure of magnetic fields. His ingenious model mechanism to illustrate the ethereal medium is now required to perform a new duty. It must be adapted to illustrate how it is that when iron is placed in a magnetic field it affects and is affected by that field. How can the presence of iron increase the amount of rotation therein going on? How can the rotation going on in the field set the iron molecules, or rather the ether connected with the matter of those molecules, into rotation? Here, we must confess, the analogies become a little mixed, and perhaps a little forced also. Frankly accepting Ampère's hypothesis (in modern dress) that the molecules of iron (should it not be its atoms, rather?) have molecular currents circulating around them, it is laid down that these molecular currents are permanent in each particle, each atom being of infinite conductivity. [Atoms, in the modern view, have capacity and self-induction, but no resistance]. The act of magnetisation simply consists in making them all face round so as to be oriented in obedience to the magnetising force. So far so good. But when we have to account further for the permeability of iron, for its extraordinary power of multiplying the magnetic forces in the field, another and entirely new conception is introduced, having nothing to do with Ampère's hypothesis, namely, that the iron atoms are more dense than those of any other substance. The wheels, in fact, which represent in the model the atoms of iron, must be made heavier, so that though they are set rotating when the gearing rotates, there shall be a greator "amount" of rotation as the result; and, though it is not expressly so stated, it would appear that the intermediate negative wheels will require to be negatively dense in correspondence. Magnetic permeability is accordingly (pp. 206 and 222) defined to be density of the ether in or of the atom, a notion very difficult of acceptance. Consider the whole range of facts about magnetic permeability; how it is small, and constant, for all ordinary non-magnetic media; how it is large and variable for magnetic media; how in the case of iron it varies from 30,000 down to two or three, according to the stage of saturation; and how, lastly, at any given stage of saturation it may be quite different according as to whether the antecedent process was one of ascending or of descending magnetisation. Can all this be adequately represented by taking permeability as the density of the ether? How can the density of the ether in the iron vary, and the ether yet be incompressible? Even if the theory be possible, is it, after all, true or even probable? In face of the fact that the substances which themselves are magnetisable are also those which possess magnetic permeability, and that the two properties are probably only two aspects of the same phenomenon, is it not contrary to the rules of philosophising to attribute the one to the molecular currents of Ampère, and the other to the quite different cause of a hypothetical variation in the density of the ether?

If magnetisation and permeability are to require each such very different modes of explanation, how comes it that the permeability of iron at any stage is so nearly proportional to the difference between the actual value of the magnetic induction and the maximum value to which it can (practically) be pushed?

Prof. Lodge takes, indeed, his own special view of the Ampèrean currents. According to him they pre-exist, and the act of magnetisation consists (p. 149) "merely in facing them round, so as to look all one way." He supports this by the acute observation (which though at once obvious, we do not remember to have come across before) that the Ampèrean currents cannot possibly be originated by the act of magnetisation, as induced currents in the atoms, because (p. 154) they are in the wrong direction, and would (by Lenz's law) necessarily circulate in such a sense as to oppose the magnetising forces. He accepts Prof. Hughes's view—and we wish he had more fully discussed Hughes's experiments on molecular magnetism—that in an ordinary non-magnetised piece of iron the polarised molecules are shut up into little self-closed circuits, which open out when placed under a magnetising force. The ordinary "higgledy-piggledy arrangement" of the molecules is the arrangement of minimum energy to which all magnetised bodies tend to return; to which, indeed, all fluids, after having been subjected to a

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magnetising force, instantly return. "Hence (p. 161) we learn that the specially demagnetising portion of a magnetic current (query current) is the fluid portion; and the greater the proportion of the fluid portion to the whole, the more easily is demagnetisation accomplished."

Nor is this the only serious criticism which must be made upon Prof. Lodge's new theory of the constitution of a magnetic field. Granting that a medium so constituted may act "in a very electrical manner," would it act in an entirely electrical manner? Even if it did, is not this construction of cogged wheels and slipping wheels, with alternate, positive, and negative rotations, too gross a caricature of the mechanism of the magnetic, or rather of the electromagnetic field, to be admissible? In the first place, the cogged-wheel diagrams absolutely refuse to work unless the wheels are arranged in square order. If arranged in any other, as are the cells in a honeycomb, as the columns in a basaltic rock, as spherical shot do when heaped up, as rings, or cylinders, or cones, or spheroids would do when heaped together, or in any other natural mode of aggregation, then they would absolutely refuse to work—the teeth of the gear would jamb. In the second place, though the diagrams represent as in one plane the wheel system, the author distinctly asks us to picture the medium as filled with such wheels, his flat pictures representing sections through vortex cylinders or vortex rings. This adds seriously to the difficulty mentioned above—that the wheel-work must necessarily be arranged in square order. Add to this the hypothesis that in electrolysis the positive and negative elements of the medium move pass one another in parallel processions (p. 86), and it will be seen that the complication becomes quite bewildering. Lastly, there is the serious objection that if cogged wheels devoid of slip are to represent a non-conducting medium, the very mechanical principle of cogged gearing intervenes to prevent the model from representing the facts; for if there be no peripheral slip no one wheel can rotate without every other wheel in the entire mass of the medium from end to end rotating through an equal angle, whereas the electrical facts require us (p. 188) to consider the rate of spin to diminish as the distance from the centre of disturbance increases. The model is, however (saving for the intermediate negative rotations), only an attempt to give the uninstructed a crude idea of vortex-motion, and those who have already studied hydrodynamics and know what vortex-motion is, will require no such model to fix their ideas. They will, however, thank Prof. Lodge for enabling them to see so clearly how it comes about that electric currents are propagated by lateral forces, not by end-thrusts in the wire, as the language of the ordinary electrician would lead them to suppose.

There is one other feature in Prof. Lodge's theory open, if not to criticism, at least to serious debate. By his views we are led back to a *two-fluid* constitution of the ether, whereas for the past quarter of a century we have been steadily progressing toward the other view that electricity whatever its ultimate nature was one entity, not two. The experimental reasons alleged for this retrograde step are enumerated on pp. 168-9, as six in number; but it is frankly admitted that several of these have nothing to do with the essential facts, and on p. 220 only three of them reappear. Let us examine these reasons for the alleged "doubleness of constitution." First, there is electrolysis; secondly, the absence of mechanical momentum in currents and magnets; thirdly, "the difficulty of otherwise conceiving a medium endowed with rigidity which is yet perfectly fluid to masses of matter moving through it." With respect to electrolysis, it is the most obvious fact that at the two opposite electrodes of the cell the two sets of atoms of the decomposed liquid are respectively liberated, and doubtless this looks very much as though there were two opposite currents, one positive, one negative. But there are two other facts, not quite so obvious, certainly not so universally known, which, however, are in such a matter quite as intrinsically significant, namely, that pure binary substances, such as pure water or pure hydrochloric acid, are not electrolysed, but require the presence of a third substance or of a solvent; and that in all electrolysis there is, over and above the decomposition of the decomposed substance, a motion of the substance *as a whole* through the liquid, so that it may be that the apparent travelling backwards of the electro-negative atoms may be nothing more than a result of the travelling forward of the rest of the binary substance. With respect to the apparent absence of mechanical inertia from electric currents, the search for an explanation of this, which crops up again and again in Prof. Lodge's book, seems to lead him almost a Will 'o-the-wisp dance. If electricity is not matter (and Prof. Lodge is apparently quite sure it is not), and if electromotive force is defined to be that which moves or tends to move electricity, why on earth should he expect electromotive force to move or tend to move matter? Prof. Lodge will probably live to smile at the importance he has attached to this idea of electric inertia. Lastly, with respect to the difficulty of conceiving otherwise of the requisite rigidity of the fluid medium, he surely must not omit the time question; for one has not to go any further than such ordinary fluids as air and water to see how such media, especially water, through which it is quite easy to propel solid bodies *slowly*, are enormously rigid (as the speed of sound through them shows) for rapid motions. Given such a further constitution as will make them for rapid motions rigid to shearing stresses, all the rest is a mere question of degree, and does not necessarily involve a duality of constitution. Time was when the ascent of a balloon would have been considered to conflict with the laws of gravitation. To explain it, apart from the properties of the air, would have required us to assume matter to be of two sorts, one of which obeyed a law of gravitation, and tended to fall, whilst the other obeyed a law of levitation and tended to rise. But no one now for a moment would seriously argue in favour of the duality of matter. We doubt whether the duality of the ether is true; we dispute the necessity of such a hypothesis to explain the facts of electricity. Prof. Lodge objects to the plain statement that the ether is electricity; in lieu of this he prefers to say that "the ether may be sheared by electromotive forces into positive and negative electricity." This may be something more than a play upon words; but if so, what is the meaning of the "neutral ether" mentioned on p. 350? Is it the same thing as the "neutral electr city" of the two-fluid electricians which can be decomposed into positive and negative?

The fourth part of Prof. Lodge's work relates to electric radiation, and here he is on his own peculiar ground. Having pointed out how the discharge of a Leyden jar is oscillatory, and how it sends out waves into the surrounding medium, he shows how to calculate from the static and magnetic capacities of the circuit the frequency of the oscillations, and the length of the resulting waves. He works up the subject toward the electro-magnetic theory of light in the following ingenious way:—For a condenser having a capacity of 1 microfarad, discharging through a circuit of 1 secohm inductance the rate of oscillation is 157 per second, and the wave length about 1,200 miles. For a common pint jar discharged through a pair of tongs will set up waves not longer than 15 or 20 metres, at the rate of ten million per second. For a thimble-sized jar the waves may be only about 2 or 3 feet long. "Continue the process of reduction in size further, and ask what sized circuit will give waves 6,000 tenth-metres (or 25 millionths of an inch) long. . . . This gives us at once something near atomic dimensions for the circuit, and suggests immediately that those short ethereal waves which are able to affect the retina, and which we are accustomed to call 'light,' may be really excited by electrical oscillations or surgings in circuits of atomic dimensions." So much of the volume is devoted to the development of the relation between optics and electricity that it is impossible to discuss this section in the necessarily limited space of a review. A fair account is given of Kerr's researches, but the explanation offered by the author of the rotation of the plane of polarisation, according to which it depends upon hysteresis, is open to serious doubt. It conflicts further with Kundt's classification of substances according to their properties in this respect.

There are many good things in the book which have not yet been noticed: the capital comparison between heat-conduction and electrical conduction on p. 66, the contrast between an electric telegraph and the oft-attempted magnetic telegraph on p. 198, the judicial pronouncement on the volta-contact theory on p. 109, the hitherto unpublished researches on pp. 11, 121, 154, 160 and 215, and the acute observation on the dissipa-

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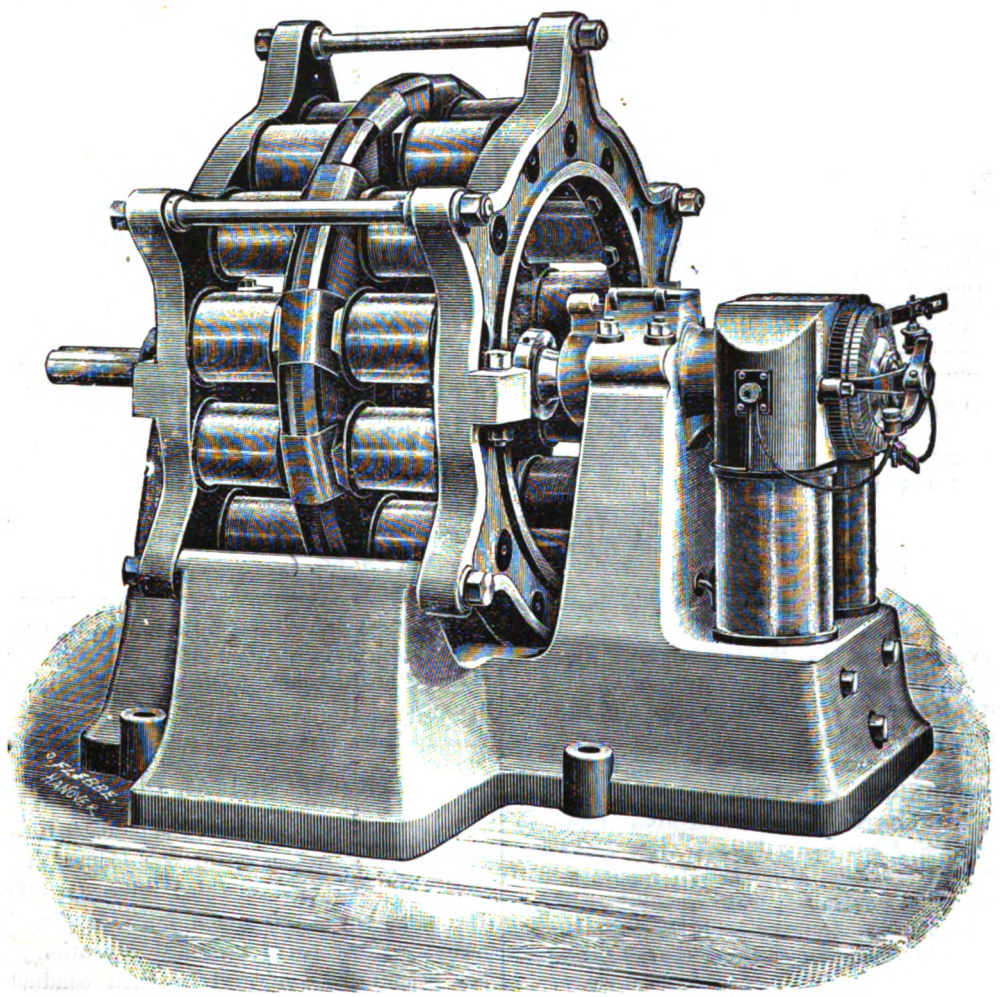
tion of energy by substances of intermediate conductivity on p. 274.

There are also some weak points of a minor order. The term "throttle" is used on p. 243 in a sense different from that introduced by Lord Rayleigh. Young students and general readers will be puzzled by the use of the words "speed" on p. 69, and "path" on p. 161, the sense of which is not defined. No mention is made of Warburg's researches on work lost in a cycle of magnetisation, which preceded those of Ewing. But these are minor matters and can readily be adjusted when a second edition is called for. Prof. Lodge's book is certainly successful in its main attempt to bring vividly forward in a tangible and non-mathematical manner the gist of modern knowledge respecting the real nature of electrical actions and of electricity itself. No one can rise from even a first reading of Prof. Lodge's book without feeling that he has made a big stride toward understanding what electricity itself is. But this is not saying that everyone will find the book easy reading. It is not by any means all milk for babes. But then Prof. Lodge is a strong man, and writes for strong men.

THE KAPP ALTERNATOR.*

Schio, a small town in Northern Italy, has now a central electric light station, which has been erected to the order of a local company by the Oerlikon Engineering Works. The generating and transforming plant is of the Kapp type, made by the Oerlikon firm, and the accompanying illustration, for which we are indebted to our esteemed contemporary, *Industries*, represents one of the two alternators at this station. In this machine the armature has an iron core, composed of thin band iron coiled upon a cast iron supporting ring, and provided with fibre driving horns, by which the armature coils are supported. The field-magnet cores are cylindrical, and of wrought iron 4⅛in. diameter, secured at their outer ends in cast-iron yoke rings, and provided at their inner ends with rectangular pole shoes, between which the armature revolves. On the armature there are 14 coils, each consisting of 80 turns of 120 millimetre wire wound in two layers, and the armature resistance is 1·8 ohm. There are 28 magnets, each wound with 186 turns of wire, and the total field resistance with all the magnet coils in series is 1·76 ohm. The machine, when driven at 600 revolutions per minute, is intended for an output of 30 amperes at 2,000 volts terminal pressure; but, on trial, has been loaded up to 40 amperes. As will be seen from the illustration, an exciting dynamo is combined with the alternator, the magnets of the exciter being fitted into a prolongation of the main bed-plate, whilst the armature is mounted on the spindle of the alternator. This dynamo is used not only for exciting the field of the alternator, but also for lighting the station. The following figures, supplied by Mr. C. E. L. Brown, of the Oerlikon Works, give the result of a test of the machine. The speed was, during the test, kept constant at 600 revolutions per minute, and the terminal pressure was noted for different degrees of excitation, no current being allowed to flow through the armature of the alternator:—



Kapp 60-Kilowatt Alternator

Exciting current amperes.	Exciting energy. Watts.	Terminal pressure. Volts.
9	142	1,000
14·5	368	1,700
17	510	2,000
18	573	2,100
21	775	2,400

When a current of 30 amperes was allowed to pass through the armature, the terminal pressure of 2,000 volts was obtained with an exciting current of 21 amperes. This requires an expenditure of energy for excitation of 775 watts, or about 1·3 per cent. of the total output; whilst the loss in the armature due to its resistance is 2·7 per cent.

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THE TECHNICAL INSTRUCTION BILL.

In spite of the determined opposition with which it has been met by a certain portion of the House, the Technical Instruction Bill was read a third time on Wednesday evening. We have never put much faith in the sincerity of Parliamentary advocates of technical education; and our suspicion has been fully confirmed by their conduct in the House of Commons during the present week. Had there been any strong and general desire to pass the Government Bill dealing with this important subject, the insignificant band of obstructionists who have kept the House into the small hours of the morning wrangling over petty amendments, which had no other object than to delay and defeat the measure, would have been met by a larger and more determined body than the fifty or sixty Government supporters who languidly followed it into the division lobby. As to the 15 or 18 malcontents who occupied themselves in concocting fresh reasons for reporting progress, or discovering grave defects in the Bill, it has been plain from the first that they had made this a sectarian struggle, and that to secure a sort of negative triumph for the Board Schools was deemed of far greater moment than to make any positive advance in technical education. That the Board Schools would not be entrusted with the task had become evident in the earlier part of the Session; and

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from that time to this there has been a dogged determination on the part of the Board School partisans to prevent anybody else undertaking it. On the other hand, the friends of Voluntary Schools are by no means anxious to figure as opponents of Board Schools; and their desire to see technical education placed outside the influence of one set of schools is not proof against their latent desire to see both sets controlling it equally.

The history of the Bill has been rather singular, and is highly instructive. Last year it escaped any direct opposition, partly because of the prevailing enthusiasm for technical education, which was then thought to be the only possible safeguard against industrial ruin; and the Bill was only suffered to lapse through there being no time to pass it. This year, with renewed signs of prosperity, the enthusiasm seems to have cooled down; but, at all events, on its reintroduction in the present Session the measure was met by a criticism which speedily put an end to its career. The Technical Education Bill was withdrawn by the Minister who had charge of it, with the frank declaration that it was beyond the ingenuity of man to frame a measure of that kind to satisfy the conflicting aims of Board School and Voluntary School partisans. Sir W. Hart-Dyke, however, had underrated his resources; for, after a few weeks' reflection, he had contrived a Bill which avoided all the snares of its predecessor, and which might reasonably be expected to disarm the hostility of Board Schools and Voluntary Schools alike. This was a Technical Instruction Bill, the essential change in its character being indicated by the fact that the system proposed was not to form part of the national education of the country, but to be administered by the Technical Department of South Kensington, and supported out of the rates levied by local authorities *other than* Board Schools.

This was an ingenious device to conciliate the friends of Voluntary Schools, to whose interposition the failure of the Technical Education Bill was due. They had urged, and we think with justice, that to give the Board Schools the exclusive right to raise money for technical education, as the original Bill proposed to do, would be not only unfair to Voluntary Schools, but unsatisfactory to the country at large, seeing that a very large proportion of the industrial classes are still educated in schools supported by voluntary contributions. So obvious was this contention that no sooner was it put forward than the fate of the Bill was sealed. It would have put technical education exclusively in the hands of rate-supported schools, and would have exposed the Government to the charge of compelling Voluntary School pupils to attend Board Schools in order to obtain the sort of training which Parliament had declared to be desirable for all classes of pupils. Much to the discomfiture of Board School representatives, however, the Government, as we have said, discovered a way out of the difficulty, affording technical education, supported from non-sectarian sources, for all who cared to avail themselves of it. The Bill had the twofold merit of separating the combatants, and allowing technical education to be perfectly voluntary. But one of the combatants was determined not to be kept back. Board Schools are the recognised educational machinery, and to none but Board Schools should the right to tax for educational purposes be transferred. Such was the attitude taken up by the partisans of the Board School system; and it meant nothing less than this, that if the Board Schools were not allowed to continue in their exclusive right, there should be no rate-aided technical education at all.

Although the Bill has assumed its present shape, so to speak, by accident, and only as a working compromise, it seems to us to be a measure which is eminently practical and to the point. There is a distinct advantage in handing over the business of technical instruction to a technical department; and although South Kensington is not all that could be desired, it is much to be preferred to the Schools Boards, who would each work independently and on no consistent plan. The local authority responsible for raising the funds may be trusted to supply them only where the requirements of the town or district demand such help. Managers of Board Schools, on the other hand, as we know by past experience, are only too anxious to add to the list of subjects taught anything that will increase the importance of the management. Indiscriminate technical instruction, irrespective of the needs of the pupils, would be worse than useless, being thrown away on lads who do not want it, and not carried far enough for lads who do want it. The voluntary technical classes which it is intended to encourage under the present Bill are just what is needed to test the question whether the rising generation artisans desire to be technically instructed, and to determine the precise kind of instruction most needed in the several localities.

PARIS INTERNATIONAL ELECTRICAL CONGRESS.

(FROM OUR SPECIAL CORRESPONDENT.)

Friday, August 23.

Although the official opening of the Electrical Congress took place on Saturday, the proceedings may be said to have really begun on Friday evening last, when a joint meeting of the Institution of Electrical Engineers and the Société Internationale des Électriciens was held at the Société d'Encouragement. Sir William Thomson was voted into the chair. Colonel Sébert was the first speaker. He spoke a few words only, offering in a very pleasant and cordial manner a hearty welcome to the company on behalf of the French Electrical Engineers. Sir William Thomson next spoke and gave a short *résumé* of the history of electrical progress since 1881, the date of the last Congress Sir William began his speech in French, and was proceeding apparently quite to the satisfaction of his French audience when he suddenly resumed the use of his native English, declaring, much to the amusement of his hearers, that he would try their patience no longer by his halting attempts to speak the language of the place. M. E. Mascart followed with a speech, in which he complimented Sir William individually and everybody else generally, and thus succeeded in producing good humour all round. After this M. Chardonnet entered into an explanation of his newly-invented process for the artificial production of silk, which he illustrated by a small working model, the fact that the model was worked by an electric motor being apparently considered a sufficient justification for the introduction of the subject at an electrical congress. Decidedly the most interesting feature of the evening came next, in the exhibition by M. Carpentier of his "Mélographe." This is an electric arrangement whereby a piano which is played upon, prints or marks the music on paper in such a manner that the same music may be reproduced mechanically by passing the marked or printed paper once more through the piano. In principle this instrument is not new, but M. Carpentier has brought the mechanism and the general design to a high degree of perfection. At present we understand he has no idea of making his invention useful to musical composers, but we see no reason why it should not be developed into a convenient system whereby composers may delegate to assistants the drudgery of producing their copy in proper form for the printer. This instrument is to be on exhibition during the whole of the Congress week. An exhibition of the Edison phonograph was then given by Col. Gouraud, and a buffet supper, at which Mr. Edison assisted, brought the meeting to a close. Amongst the various exhibits of the evening was a specimen of a Crompton armature winding, and a very convenient form of potentiometer, also devised by Mr. Crompton, who himself explained the instrument to Mr. Edison, Prof. Hughes, MM. Potier, Hospitalier, and others. The potentiometer has a four-metre bridge with multiple switch, so that six separate E.M.F.'s can be compared with a standard cell.

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Saturday, August 24.

On Saturday morning, at 10 o'clock, the Conference was formally opened by a speech by M. Mascart, in which he explained the arrangements made for the succeeding week, and by the election of office-bearers. M. Mascart having been elected president on the motion of Sir William Thomson, M. Fontaine proposed, and it was resolved, to appoint Sir William Thomson Honorary President, and MM. Cochery and Berger "Presidents d'Honneur." There were further chosen six Vice-Presidents, namely, MM. Ferraris (Italy), Kareis (Austria), Potier (France), Preece (England), Rousseau (Belgium), Stoletow (Russia), and Weber (Switzerland). M. Joubert, Secretary of the French Physical Society, was appointed Secretary. The "Comité d'Organisation" had proposed to form six sections of the Congress, but it was formally resolved to reduce the number of sections to four. Thus the originally proposed second, third, and fourth sections (which were devoted respectively to machines, electrochemistry, and lighting) are now combined in one, the second. This simplification is felt to be a great improvement, as the same people practically desire to attend the meeting of all the three original sections now amalgamated. It is estimated that about 800 persons attended this opening meeting, but not more than a hundred entered their names on the register, and of these only a very small number put down their Paris addresses.

On Saturday evening a demonstration of "Electric Undulations" was given by M. Egoroff, at 44, Rue de Rennes. These very beautiful experiments have aready been described by J. J. Thomson, in England, before the Royal Society. They consist in an extension in a particular direction of the researches of Hertz. M. Egoroff's apparatus worked very perfectly on Saturday last, but M. Egoroff himself, who is a Russian, has not the faculty of clear public exposition, and, in fact, he addressed a large portion of his remarks in a low conversational tone to the wall instead of to his audience. The vacuum tubes he uses, and in which the phosphorescent arc light is produced, showing the passage of electric energy through the air in which they are placed, are ordinary Geissler tubes, prepared by the ammoniacal process. Only certain tubes, however, exhibit the phenomenon, and M. Egoroff cannot as yet distinguish beforehand which tubes will and which will not do so. He is clear, however, as to the behaviour of the tube depending in some respects upon its exact dimensions. M. Egoroff uses an alternating current, and two or four brass or copper plates, between which the electric energy is radiated or discharged through the dielectric medium. The plates were on Saturday placed parallel in the same plane. In the space close to the plates the vacuum tubes exhibit a vigorous glow, the production of the light, however, depending on the position in which the tubes are held with regard to the lines along which the electric energy flows, these lines close to the conductor having been shown by Prof. Poynting to be normal to the surface of the conductor. Also, the tubes can be shaded from the action by the interposition of many substances, such as rubber silk or cardboard. Parallel conducting wires being stretched from the centres of the plates to the other end of the room, the passage of energy through the space between and around the wires is manifested by help of a large insulated ring of copper wire, the circuit of which ring is broken at one point so that the alternating current generated in it is exhibited by sparking between the points of the break. As this apparatus is varied in position along the wires so as to place it at different distances from the charged plates, the light waxes and wanes, thus showing the nodes of the interfering waves of electrical excitation in the dielectric. M. Egoroff made a main point of insisting on the circumstance that the places of maximum electrical excitation were also places of maximum magnetic strain; but it must be confessed that his experiments to prove this seemed to give very indefinite visible results. This *séance* was attended by over a hundred members.

Sunday, August 25.

On Sunday morning, at the early hour of eight, a large company of Congress men, with a few ladies, assembled at the base of the Eiffel Tower, and proceeded, under M. Mascart's escort, to inspect it. Although there is nothing to see at the top beyond an ordinary electric lighthouse arrangement and ordinary meteorological instruments, those who got there insisted on examining these in so leisurely a manner that M. Mascart at last declared that he had made a calculation that it would take seven days to get the whole company through if the circulation continued at that rate. He therefore peremptorily declared that the ascent should stop, and enforced this declaration by causing a ladder to be dismounted from its bearings and an iron trap door to be lowered on the heads of the unfortunates below. At one time it was feared that the friction between the up and down streams on the staircase had caused a charge of dangerously high potential to accumulate on the outer surface of the Tower, but this was ascertained to be an unfounded rumour, probably because of the dissipating action of the large number of lightning conductors sticking out from all points of the structure. Happily no serious misadventure took place, and an hour later the *élite* of the scientific world became dispersed and lost in the vulgar crowd of humanity on the lower stages of the Eiffel Tower and in the gardens below.

Monday, August 26.

On Monday morning the Sections met at nine o'clock, and with very little delay proceeded to business by completing the appointing of officers. From the extremely short time in which this was accomplished it was apparent that everything had been settled beforehand so far as this part of the proceedings was concerned. If the same forwardness of preparation had been evidenced as regards the papers, the time of the first day might have been utilised to a greater extent. The following is a list of the official appointments:—

Section I.—Units and Measures: President, M. Lippmann; Vice-Presidents, MM. Bjerknes and Stoletow; Secretary, M. Violle; Assistant-Secretaries, MM. Armagnat and Lepage.

Section II.—Industrial Applications: President, M. A. Potier; Vice-Presidents, MM. Ferraris, Hippolyte Fontaine, G. Forbes; Secretary, M. E. Hospitalier; Assistant Secretaries, MM. C. Jacquin, J. Laffargue, G. Roux.

Section III.—Telegraphy, Telephony, and Signalling: President, M. Fribourg; Assistant Secretary: M. Dumont.

Section IV.—Electro-Physiology: President, M. Gariel. Assistant Secretary, M. P. Bary.

This preliminary business over, M. Crova proceeded in Section II. (Industrial Applications) to read a Paper whose object was to suggest improved and more systematic methods of comparing lamps with respect to their lighting power; in other words, it advocated the introduction of methods of photometry founded on more rational principles. He asked that the definition of the lamp should include three things—first, the voltage for its normal intensity; second, the tint or colour composition of its light; and third, its lighting power. By the help of curves of intensity, the horizontal ordinates being reciprocals of the wave lengths or of the period of vibration, each lamp having a curve peculiar to itself, a comparison with sunlight was established in very much the way as has been so very frequently done by others. Where the curve of a lamp crosses the sunlight curve the same intensity is obtained from both sources. A number of figures were given regarding the watts at various intensities, and the watts at the "point of extinction," *i.e.*, the point below which the lamp is not incandescent. Measurements of the intensity in the various horizontal directions from the lamp were compared by means of polar curves, and it was proposed to try to get a mean of these by revolving the lamp at a suitable speed on the photometer, but either from actual variation in the light or from imperfection in the arrangement of the apparatus, there appeared to be practical difficulty in getting a satisfactory mean. The colour compositions were taken by means of a comparison of the values of the red in each light at a wave length of 557. In each lamp the tint thus determined varies largely with the number of watts. The discussion following this Paper was limited to a few remarks addressed in a very informal way by the chairman to the reader of the Paper, and a spirited attack upon the whole principle of the Paper by M. R. V. Picou, who said that under the various conditions of actual practice the power most economically spent upon a lamp depends upon the cost of mechanical horse-power in each particular locality and is extremely variable, and

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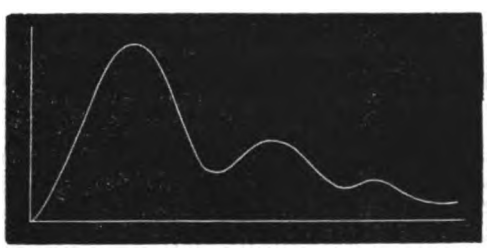
that, therefore, there was no "normal" intensity or number of watts which could be said to be proper to each lamp. M. Crova's Paper, however, was generally admitted to be a very methodic and scientific attempt to introduce greater rationality into the photometry of electric lighting.

The president, M. Potier, now announced, considerably to the surprise of most people, that this was the only Paper that was offered for the first day, whereupon M. Bède charitably offered to assist the Congress on its way by giving an impromptu explanation of his views upon the combination of the heating with the electric lighting of industrial and other establishments. These resolved themselves pretty much into a recommendation to use for the heating the exhaust steam of the engines needed to drive the dynamos, running the engines throughout the day by charging accumulators with them, which accumulators would assist the dynamos during the dark hours. Thus the dynamo plant, including its driving engine, was reduced in size and cost, and the cost of separate heating boilers was avoided. This, of course, is a most serious and important industrial question, but its logical necessary connection with electric lighting seems doubtful, seeing that the exhaust steam from an engine can be equally well utilised for heating whatever description of work the engine may be doing, whether driving a dynamo or any other kind of machine. At any rate, the section did not choose to discuss it, and, after an hour and a-half of intellectual labour, suspended its meeting.

Meantime Section III. had been listening to an excellent Paper, by M. Mercadier, upon the relation between the intensity of sound emitted from a telephone receiver and the thickness of the vibrating diaphragm, the results of his experiments, as illustrated by curves which have the same characteristics as diffractional curves. The general character of the curve obtained is shown in the subjoined sketch, where the horizontal



ordinate gives the thickness of the plate, and the vertical the intensity of the sound emitted by it. It will be seen that this intensity at first increases with the thickness, then decreases, once more increases to a maximum, then, after falling to a lower minimum than the first, increases to a third maximum. His method of determining the intensity of sound consisted in determining exactly the distance at which it ceased to be heard. Unfortunately his arrangement gave this distance in a way that evidently depended on the sensitiveness of the ear of the experimenter, and as this would vary from day to day and also from hour to hour even if the measurements were all made by the same person, the results were felt to be to some extent vitiated by this circumstance. Thus with very thin diaphragms great intensity can be obtained, but the power of articulating—the power of reproducing all the minute distinctions of sound upon which speech depends, increases rapidly with the thickness. Therefore a middle course has to be followed by adopting a plate of such thickness as will give sufficient intensity, and at the same time a high degree of articulation. The harmonics of the plate alone were insufficient for such articulation, and the theory adopted by M. Mercadier is that besides the molar vibrations of the plate taken as a whole, there arise "molecular" vibrations capable of originating sonorous waves in the surrounding air. *How* such vibrations could be produced by merely internal molecular motions was not explained, and this theory is repudiated by Messrs. Hughes and Preece, the latter of whom, speaking in English, announced in this Section, on the following morning, their adherence to the more ordinarily understood theory of molar vibration of the plate. In this Section also, there proved to have been only one Paper provided for the first day, and the discussion of it was not even commenced before the adjournment.

In Section I. (Units and Measures) the first communication was from M. Bjerknes, who gave a *résumé* of his most recent researches into the analogies between hydro-dynamics and electro-dynamics. The President laid before the Congress the proposition of M. Pellat to adopt an electro-dynamometer-balance as the standard instrument for the measurement of currents. This brought forth a protest from Sir William Thomson, who said that with proper precautions the electrolytic method was far the most accurate, and that his own electro dynamic-balances were all calibrated by help of a voltameter. He said that there was no difficulty in getting accuracy by this system from 0·01 to 500 amperes. M. Mascart and M. Lippmann both agreed with Sir W. Thomson, and thus M. Pellat's proposal was at once crushed out of existence.

The question of measures of potential was introduced by Sir W. Thomson, who insisted on electrostatic methods, and said that nowadays an electrometer to measure 5,000 volts was an easy thing to make. M. Lippmann then explained capillary instruments for measuring small potentials, and declared that these instruments can be made to show $\frac{1}{10000}$ of a volt.

Section IV. (Physiological) found little to do. The President read a Paper by M. Maurice Mendelssohn on "Some Electrical Phenomena in Man," and then the meeting was adjourned until Friday.

In the afternoon the members made visits to the Telegraphic and Telephonic Sections of the Exhibition. Here M. Mercadier expounded his various exhibits, and a long series of Hughes's instruments of rather ancient pattern attracted attention. Mercadier's acoustic multiplex telegraph excited much curiosity, but Baudot's and Munier's quadruplex instruments contributed the greatest novelty and interest to the visit. Munier's arrangement is the more complicated of the two so far as mechanical arrangement is concerned, but Prof. Hughes seemed to feel a prefereuce for it on account of its greater magnetic simplicity. The four instruments combined can transmit along the one wire 650 letters, or about 140 words per minute, each instrument making 35 turns per minute, and averaging one word per turn. After leaving the Pavilion of Posts and Telegraphs most of the members made their way (*viâ* the Decanville Railway) to the pavilion of the Société Générale des Telephones, which lies just to the east of the Eiffel Tower. Here is the Telephone Exchange connecting the numerous subscribers within the Exhibition, and the general Parisian system.* This pavilion also contains an extensive collection of telephonic apparatus, including batteries, switches, call-bells, and cables, but there is nothing calling for special comment. In a room on the ground floor the members had the privilege of listening by telephone to a morning performance then proceeding at the Folies Dramatiques. With this episode the conjoint labours of the day were brought to a close.

Tuesday, August 27.

On Tuesday morning the Sections met as usual at nine o'clock. In Section I. the first Paper was from Mr. Van Aubel, who recommended for the measurement of the intensity of magnetic fields the methods of Profs. Stenger and Angström as being by far the most accurate. The bismuth spirals of Lenard and Howard are good for workshop measurements, especially when the fields are intense and of small volume; but as the resistance changes with the intensity of the field according to an unknown law, a calibration of each spiral is needed. An interesting and lively discussion then arose on the subject of nomenclature, introduced by M. Szarvady, who pointed out that the Congress of 1881 had omitted to establish any practical unit of magnetic intensity, and endeavoured to supply the omission. His definition of the unit was that intensity of field which would produce one volt electromotive force in a conductor one centimetre long, when cutting nominally the lines of the field at a velocity of kine (1 centimetre per second). This unit would be 10^8 C.-G.-S. units, but a more convenient size of unit for practical purposes would be 10^7 C.-G.-S. units. The name "Gauss" was proposed for this unit. M. Guillaume then advocated the adoption of the megadyne per square centimetre, with the name "barie"

* For an outline description of the methods adopted in the Paris Exchange, see *The Electrician*, May 31, 1889, p. 86.

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as the unit intensity of mechanical pressure, apparently in ignorance of the adoption in England last year of the term "barad" to mean 1 degree per square centimetre. A unit of entropy was proposed by M. Moser, who wishes to call it "trop," for apparently no particular reason except that there are four letters in the word, and that these four enter into the word entropy. The definition of the "trop" was

$$1 \text{ trop} = \frac{1 \text{ joule}}{1 \text{ degree c.}}.$$

On the proposition of Mr. Violle the $\frac{1}{20}$th part of the absolute photometric unit proposed by the 1884 Conference was adopted as the "bougie decimale," it being very nearly $\frac{1}{10}$th of a carcel. A number of names having been proposed and carried to add to the committee to report on units, the meeting ended after a description of a bi-polar induction apparatus, whereby the elliptic motions of planets and their simultaneous rotations on their own axes could be reproduced on a small scale.

In Section II. the Committee appointed the day before reported their recommendation that incandescent lamps should be judged according to the following definition:—"The degree of incandescence of a lamp is the quotient of the intensities (relatively to the carcel) of its two radiations of wave-lengths $\lambda = 582$ and $\lambda = 657$." They also recommended that the "statement of the lighting power of a lamp should be accompanied by the statement of the degree of its incandescence at that power," and that "this lighting power should be stated in 'bougies decimales.'" The Congress confirmed these recommendations by vote. The subject of photometry was discussed further for some time. Prof. Silvanus Thompson then read a mathematical Paper on continuous-current transformers, and referred to an installation at Ipswich, where the transformer reduced the voltage from 1,500 to 100. M. Maurice Leblanc then explained how he had succeeded in reducing the effects of self-induction in alternating-current motors (see *The Electrician*, August 2, *et seq.*). Mr. Gisbert Kapp protested against this gentleman's low estimate of the character of existing alternating-current dynamos, and cited the experiments by Mr. Mordey.

The proceedings in Section III. began with Mr. Preece's statement on Mr. Hughes's and his own behalf already mentioned. M. Merczyng then described a new long-distance telephone arrangement, the line having a resistance of 2,000 ohms and a capacity of three microfarads. The specialty consists in separating the line from the transmitter and the receiver by two condensers, of which that at the receiving end is always to be made of smaller capacity than the other, the two actual capacities being 0·2 and 0·5. The line is an iron wire 300 kilometres long and five millimetres in diameter. Then followed a long discussion on the use of dynamos in telegraphy, introduced by a Paper by M. Pierre Picard. He gave a short historical review of this subject, referring specially to Schweindler's attempt to make the differences of potential on the various lines proportional to their resistances by their interpolation of suitable extra resistances on the short lines—the want of economy in which system was strikingly illustrated by the extra resistances being often greater than the whole useful resistance—and to the New York installation, where three series of five dynamos each are used, giving each 75 volts, and where four of each set of five can be arranged in series so as to give 300 volts. The author then described his own system, which has been in operation in Paris over a year. It consists in taking what may be called the main current (15 to 20 amperes) through a resistance of from 5 to 6 ohms. This resistance is carefully graduated, and forms a scale of potentials from which the various currents are taken off as shunts at different suitable points. M. d'Infreville informed the Congress that this system has been used in America by the Western Union Telegraph Company for the last eight years, both Siemens and Edison-Hopkinson dynamos being used. It is also used for the "Gold and Stock Telegraph." It was stated that great economy has resulted from the use of the dynamos. Mr. Aylmer explained the progress made in this direction by the British Post Office, Mr. Preece's first efforts dating from 1873, and the system being now, as is well known, modified by the introduction of a battery of accumulators charged once a month by the electric-lighting dynamos. He has now 220 circuits served by 29 accumulators. The rest of the sitting was occupied by a description of the new telephonic post of M. Van Rysselberghe and a discussion on the construction of cells of constant voltage.

In the afternoon, the Sections, in three separate parties, made visits to the works of the Société Générale des Telephones, the Laboratoire Central d'Electricité, and the works of Sautter et Lemonnier. The installation at the Laboratory comprises a semi-fixed horizontal 20 horse-power Weyher and Richmond engine, and a 12 horse-power Lenoir gas-engine. The machine room contains a Sautter-Lemonnier dynamo, giving 70 volts and 300 amperes; an Edison machine giving 10 volts and 80 amperes; a self-excited alternate-current Gramme machine, distributing boards and rheostats. The large photometer room contains a Bunsen photometer with Dumas balance, and a Mascart photometer; the laboratory standard of light being the carcel burning 42 grammes of oil per hour. In the electro-chemistry room there is a battery of 200 Callaud cells and a battery of 60 Julien accumulators. The standardising room contains instruments of great precision for standardising resistance, E.M.F.'s, and intensities, and comprises Wheatstone bridges, a Pellat electro-dynamometer, standard ammeters, standard voltmeters, and a Mascart electrometer. The standard resistances are five glass and mercury copies of the principal standards of the Ministère des Postes et Télégraphss. In the two rooms for commercial measurements, there are two Thomson and three D'Arsonval galvanometers, a Carpentier dead-beat electrometer, a Lippmann electrometer, two Wheatstone bridges, two graduated condensers, and a collection of rheostats and various other apparatus. In addition to these rooms there is a large one for carrying on any tests that may be required, and there at the present moment Hertz's experiments are being constantly reproduced under the direction of M. Joubert. The visit to the Sautter et Lemonnier Works was most interesting. M. Lemonnier himself was guide to the company, and it was difficult to know which to admire more, the immense practical energy of the man or his clear-headed, distinct, and succinct descriptions of his machines, &c. In the midst of the noise and distraction of the workshop his little speeches at each halt would compare very favourably in point of *netteté* of expression and clearness of tone with most of the often rambling and incoherent discourses we have been listening to in the Sections of the Congress. The chief objects of interest to which attention was drawn were dynamos driven by, and mounted on the same shaft as, a form of Parson's steam turbine, giving a double grade of expansion to the steam. The normal speed is 7,000 revolutions, at which the external electrical output is 85 volts and 100 amperes. The consumption of steam is very high, being 40 kilogrammes of steam at 5 atmospheres pressure per external electrical horse-power. But evidently the extreme simplicity and very great compactness of the arrangement may in very many situations, and especially on ship-board, compensate amply for the high rate of steam consumption. A military search-light, with automatic regulation added to the hand manipulation, which latter gives the greater possibility of nice adjustment to maximum lighting power, was examined; and then a photometer for arc and incandescent lamps, whose principal interest lay in its having been designed and constructed many years ago, and yet containing some of the arrangements just now being advocated at the Congress as improvements. The visitors next examined the manufacture of the carbons for the arc lamps. These are all of the plain cylindrical form, running up to 2½in. diameter, and the carbon being mixed with petroleum. This pleasant and interesting visit concluded with an afternoon luncheon.

In the evening there was a brilliant company of *savants* gathered at the invitation of Mr. Preece and Mr. James Dredge, in honour of Mr. and Mrs. Edison at the Pavilion of the British Section of the Exhibition. Here the attractions were chiefly social, but there were on exhibit a number of Edison Telephones in connection with the Opera House, and Phonographs, two of which were giving off instrumental symphonies that had been played into them some weeks ago, and the third was engaged in reproducing whatever anyone liked to speak into it. These instruments were all acting in a wonderfully perfect manner.

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The following is one of the Reports which have been presented to the Congress :—

Electro-Physiology.

REPORT BY M. D'ARSONVAL.

The part played in therapeutics by physical agents (heat, electricity, pressure, cold, &c.) becomes more important each day, and that rightly so. The employment of physical agents is not complicated with any poisonous effect ; their action can be easily regulated and the application repeated without the least inconvenience. Modern physiology has proved that electricity, of all the physical excitants, is the most simple and efficacious for stimulating the functions of the nerves and muscles ; and furthermore the recent progress of electrical science has shown that we possess no agent which can be more easily managed than electricity. A great number of practitioners to-day employ electricity with success, but in order that their observations may be of any value for the advancement of science, and that the facts which they put forward may be checked, it is most necessary that they should know how to state precisely the conditions under which they worked. To attain this end, doctors employing electricity must learn to use the precise and simple language of electricians, and when they take the trouble to make measurements must give up using arbitrary ones. The Congress of 1881 has already made great progress in rendering obligatory in therapeutics the employment of the volt and milliampere in measurements of the continuous-current, agreeably to the proposal of M. d'Arsonval and M. Marey. To attain this end all that is needed is to borrow from electricians their methods and instruments with some small modifications to fit them for their new use. But continuous currents are not the only form in which electricity is used in physiology and in medicine. In fact, their use is rather the exception since it is applicable to only one of the two great aspects of life : *nutrition*. To stimulate *function*, on the other hand, recourse is had to discontinuous currents. In this second case the problem of measurement becomes much more complicated, for the physiologists have not much to borrow from the electricians. Nerve and muscle respond to the electrical stimulus by reactions peculiar to themselves. Contrary to what takes place in inanimate subjects, the nature of the excitation will modify completely the excitability of the living subject, if the excitation does not realise certain physical conditions, the knowledge of which is the exclusive domain of the physiologist. Therefore, to apply electricity successfully in the healing art one must be both a physiologist and an electrician. Living beings are not only sensitive to electricity, but they produce it themselves and by means peculiar to themselves. This *modus faciendi*, which differs from those of the chemist and physician, forms a decided line of demarcation between inorganic physics and biological physics, which latter is a science of very recent date. Finally, the industrial applications of electricity have made a formidable agent of this force, whose effects, comparable to those of lightning, have given rise to accidents, the study of which has the highest interest for physiologist and doctor.

These different considerations have led us to consider that it would be of interest to direct the discussions of the Congress to the three following points :—

1. The comparison of effects obtained by the employment of different medical apparatus ; the necessity of defining the currents used.

2. The nature of the self-produced electrical phenomena in living beings.

3. The effect on living beings of the discharges of the continuous and alternating-current used in the industries.

And as a corollary :

4. The precautions to be taken in electrical installations.

Comparison of Medical Apparatus.

A. *Continuous-Current Apparatus.*—This first point has been settled by the Congress of 1881, which has laid down that the application shall be measured in the practical units, derived from the C.-G.-S. system, namely, the volt and the milliampere. It would be well to add the nature of the electrodes and the area of the surface in contact with the tissues—that is to say, the current density per square centimetre. This is generally useless in physiology where the excited surface is reduced to a point.

B. *Intermittent Current Apparatus.*—This form of appliance is used above all to stimulate the nerves and muscles. Let us see first what is the fundamental law of the electric excitability of these organs. A constant current, supplied by one or two Daniell's cells, for example, causes a sharp contraction of a nerve or muscle each time it is applied to it or taken off. The muscle remains in repose if by the aid of a rheostat the current is made to pass gradually from zero to its maximum value ; but it contracts if a sudden variation in the current is produced. In fact, within the limits mentioned above, nerve and muscle are excited by the variable condition and not by the constant phase of the current. The intensity of the muscular contraction is not necessarily in relation to the energy of discharge of a condenser. The physiological excitation is not defined when we know the fall of potential and the quantity of electricity set in motion. We must know also the time of this fall and its phases, things of no importance in other matters. The curve thus obtained is the "characteristic of excitation." By reducing the time of discharge to one infinitely short, we have evidently only to consider the quantity of electricity set in motion. The discharges of condensers, and the induced current of break in induction coils realise this condition in practice. This condition of instantaneous flow of electricity is only realised in the case of condensers when they are discharged through a relatively low resistance. In exact experiments it is bad, therefore, to try to excite a body of such high resistance as nervous tissue by means of the direct discharge of a standard condenser. A Leyden jar can be discharged through a nerve or muscle without causing the least contraction if the discharge is slowed down by means of a cotton thread. Therefore it is preferable to discharge the condenser through the primary wire of an induction coil. We thus obtain induced currents which are always equal, and which are without direction. It is easy to measure the induced current of break in coulombs by discharging it through a ballistic galvanometer, and comparing the discharge with that of a standard condenser, as I described before the Biological Society in 1884. The difficulty consists in getting an interrupter to give similar breaks, more especially when they are frequent. In my opinion it is absolutely useless to have more than 50 breaks in the second, as this frequency is quite sufficient to cause tetanus of the muscle from the superimposed shocks. The only pattern of induction coil which gives a regular gradation of induced current is that of Siemens and Halske, with movable coils, better known under the name of Bois-Reymond, and which was brought into use in therapeutics sometime since by A. Tripier. From the point of view of numerical graduation this instrument has the inconvenience of not offering a simple relation between the intensity of the induced current and the amount of movement of the coils ; moreover, it is cumbrous when used to excite very sensitive nerves. In certain cases, when exciting the diaphragmatic nerve M. Brown-Séquard and I had to separate the two coils of Gaiffe's apparatus to more than 1·4m. from each other. I have graduated our apparatus in coulombs by means of a ballistic galvanometer. This instrument might with advantage be replaced, in the case of delicate experiments, by one having two-circular concentric coils, whose planes could be rendered gradually perpendicular to one another by a continuous rotary movement. The intensity of the induced current would then be proportional to the cosine of the angle formed by the two planes. A third mode of regulating the induced current would consist in weakening the battery current in certain fixed proportions by the interposition of resistances in the primary circuit. This means is the least perfect of the three, for it alters the duration of the variation of the inducing current, and consequently the duration of the induced. The current from magneto-machines is much more difficult to regulate, for it depends on a number of variables (speed of rotation, the magnetisation of the magnets, the distance of the armature from the magnet, &c.).

To resume the subject of the calibration of faradaic apparatus, all that is necessary in practice is to mark in micro-coulombs the value of the induced current of break, corresponding to each distance apart of the movable coils for a fixed inducing current. These two calibrations could easily be supplied by the maker. The E.M.F. of the induced current varies as the quantity of electricity since the time of induction is constant. Consequently the energy of the induced current varies as the square of the quantity of electricity set in motion. Therefore it is only necessary to mark it for one point on the scale.

The Nature of the Electric Phenomena in Living Beings.

All living beings are the seat of electrical manifestations. Animal electricity has been studied, especially in two tissues, the nerves and the muscles. Nevertheless it is certain that its production is much more general, and that it accompanies all the vital processes. Electrogenesis must be like thermogenesis, a cellular phenomenon due to the same cause—the life-producing combustion due to breathing. Living tissues give rise to two sorts of electrical manifestations which do not seem to spring from the same cause, viz. :—1. The *continuous* electrical manifestations called also currents of repose. 2. The *intermittent* electrical manifestations or currents of action. Currents of action have the remarkable feature about them that in certain cases, as, for example, the electrical fishes, they are capable of reaching a very considerable intensity. Further, these currents do not seem to *pre-exist* in the tissues which are their seat, but to have their origin at the moment when the organ enters on its function.

The laws which regulate the production of continuous currents have been well studied as regards nerves and muscles separated from the body. To study these currents special instruments, with non-polarisable electrodes and dead-beat galvanometers, or Lippmann's electrometers, must be used. We do not yet know for certain if these currents of repose in muscle pre-exist, or if they are due to some circumstance attending the preparation of the muscle—an injury to the muscle. Experience shows clearly that the surface of a muscle *which is perfectly intact*, does not give any evidence of electrical tension, or exhibits only very slight tension. All we can say is that the electric manifestations in muscles and nerves separated from the organism are extremely regular, and are certainly closely connected with the chemical and physical composition of the contractile substance. On this account they have the greatest physiological interest. These differences of potential, which are maintained on closed circuit on the surface of the muscle, are due to chemical action. This is evidently only another way of stating the doctrine of the conservation of energy, but it may be shown in the following experiments that :—

1. The differences of potential diminish in the isolated muscle, *pari passu*, with its excitability ; and when this latter disappears, all trace of the regular current has disappeared also.

2. This current is weakened and momentarily disappears in the anæsthesia produced by ether, that is to say, in the hindering of the chemical function of the protoplasm.

All the continuous electrical manifestations of living matter are not, *in our opinion*, immediately due to chemical action. Continuous currents can be obtained by means of purely physical actions which take place in the body. (i.) By the simple filtration of a liquid without chemical action, across a porous septum ; the converse, in fact, of Porret's experiment. (ii.) By the flow of a liquid in a tube. (iii.) The effects devised by the elder Becquerel under the name of electro-capillary currents, &c.

The intermittent electrical manifestations of which the living tissues are the seat are much more interesting. If we have just excited a muscle by any irritant whatever we shall certainly find :—

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1. Every point excited becomes negative to the unexcited muscle.

2. That the rapidity of propagation of this negative wave is the same as that of the propagation of the muscular wave (about three metres a second for a muscle of a frog treated with curare).

3. That this negative wave lasts as long as the contractile wave.

4. That the E.M.F. of the negative wave, or of the current of action, may attain the same value as that of repose (·1 Daniell), which it never exceeds.

This current of action (also, but wrongly, called negative variation or oscillation) is sufficiently strong to excite a nerve or even a muscle in which it takes place (the induced contraction of Matteucci). The laws of the current of action in a nerve follow those of the muscle. The E.M.F. of these currents is only weaker than for the muscle (·02 to ·03 of a Daniell's cell in the case of mammifers). The currents of action cannot be put down as the result of the method of preparation, for they can be easily demonstrated at each beat of the heart in the case of man and the mammifers by using the arrangement proposed by Mr. Augustus Waller in 1888. These currents attain an extraordinary intensity in the discharge of the electric organ of certain fishes, the torpedo, gymnotus, silurus, &c. The electricity is not produced beforehand in these organs. They cannot be compared to a battery or a condenser, since in a state of repose they do not manifest any external electrical potential which is comparable to the energy of the discharge. Therefore electricity is produced in these organs only at the instant in which they enter on their functions at the will of the animal. They act from the point of view of the production of electrical energy exactly as, according to M. Marey, the muscle does for mechanical energy. The nervous system no more makes electricity in the electrical organ than it makes mechanical force in the muscle, since the discharges are obtained after the separation of the organ from the nerve centres, just as in the case of muscle. If *contractility* is the property of muscle, electricity (to employ a corresponding expression) is in the same sense the property of the electric organ. No satisfactory theory has up to this time been put forward to account for these currents of action.

M. d'Arsonval has hazarded an explanation, resting on a physical basis and making use of the physical laws discovered by M. Lippmann, which establish a relation in the inorganic world between capillary and electrical phenomena. M. d'Arsonval has shown that a relation of this kind exists between animal electricity and surface tension. All phenomena at present known can be accounted for by this explanation.

THE EFFECTS ON ANIMALS OF CONTINUOUS AND ALTERNATING CURRENTS.—THE ELECTROLYSIS OF TISSUES.—PRECAUTIONS TO BE TAKEN.

Direct experiments have been made on different animals (guinea-pigs, rabbits, dogs), using electricity derived from the following sources:—1. A four-plate Holtz machine charging a battery of four large jars. 2. A battery of 420 volts. 3. Continuous-current Gramme machines of 110 to 8,000 volts. 4. Alternating-current Gramme machines having a mean potential of 300 volts. 5. Induction coils driven by accumulators. From what has been said before, a living being is most sensitive to the variations of the current; therefore it follows at once that for the same potential difference an alternating is more dangerous than a continuous current. Death is caused by electricity in one of the two following ways:—

1. *Direct Action.*—The discharge acts mechanically and destroys the tissues.

2. *Reflex or Indirect Action.*—The discharge acts on the nerve centres, and by irritating them leads to a variety of inhibitory processes known under the names of "*inhibition*" and "*dynamogénée*" since the researches of M. Brown-Séquard.

The static discharge is not fatal unless it strikes the respiratory centre directly with very well placed discharges, whose energy corresponds to about 3 kilogrammetres.

A. Under these conditions the different tissues (nerves, blood, muscles) struck separately by the discharge lose their physiological properties for good.

B. With a battery of 420 volts death is caused by long-repeated interruptions of the current. Death is due to a condition of tetanus, brought on by the current, and is accompanied by a considerable rise in temperature, which is the true cause of death.

C. The continuous-current Gramme machine is not dangerous (at 100 volts) except from the extra current of break. Compound machines have less destructive effect at the same potential, for the second coil serves as a shunt at the moment of break.

With an 8,000 volt machine, a momentary application of the current made the animal (a rabbit) give a great leap, but has not caused immediate death; a second application was necessary.

D. An alternating-current Gramme machine only causes death above a mean potential of 120 volts.

E. A coarse wire extra-current coil is more dangerous than an induction coil, especially if it is connected to a condenser. The danger from a single discharge is defined only by the *electric curve* of this discharge. The knowledge of the difference of potential and the mean current strength is not sufficient: we must know in most cases that which is immaterial in other cases, the duration of the discharge. For equal energy the danger is in inverse proportion to this duration. It is the same for alternating currents, for which we have to take into account the number of reversals per second.

The separation into two groups of the effects produced by high potential electricity has a great practical value in the sense that in the first case death is certain and instantaneous (destruction, with laceration of the tissues), whilst in the second (death by irritation of the nerve centres without destruction) life can often be restored by practising artificial respiration immediately after the accident.

The application to the nerves of a continuous current of low intensity brings on a modification of excitability known as *electrotonus*, into the details of which we cannot enter here. This modification seems to depend solely on the polarisation caused by the passage of the current between the cylindrical axis and the marrow of the nerve, for it does not exist, or only feebly so, in nerves deprived of marrow. The passage of a continuous current of an intensity varying between 10 and 250 milliamperes through any of the tissues of the organism is accompanied by electrolytic phenomena used surgically by Ciniselli, of Cremona, to destroy tissues without the effusion of blood. This valuable method, introduced into France by Tripier, seems capable of giving excellent results in skilled hands. The passage of the current in this case acts as a local caustic, depositing in a nascent condition the acids at the positive pole, and the bases at the negative. In fact, electricity acts the part of a carrier of caustic alkalies and acids, while localising their action to the vicinity of the poles. The cauterisation of the positive pole gives rise to hard and retractile cicatrices. According to Tripier, the contrary would take place in the case of cauterisation by the negative pole.

The current strengths which it is useless or dangerous to use have still to be determined by experiment, but the current may be the cause of general disorders when its strength exceeds an ampere.

ECONOMICAL SIZE OF LINE WIRE FOR CONSTANT-CURRENT CIRCUITS.*

BY B. RHODES.

The writer has for some time been accustomed to use a formula for finding the economical size of line wire for constant-current circuits, and has been requested to present it at this time. With the knowledge that it is not new, and yet that it is needed by many practical electricians, the following is submitted:—

Let X = diameter of line wire in mils.
Let A = length of circuit in miles.
Let B = price of copper per pound.
Let C = cost of power per year per horse-power.
Let E = amperes of current.

When any plant is about to be established B and E are known, C can be determined near enough for our purpose, and A will be found to be immaterial.

$\cdot 016\ X^2$ = pounds of wire per mile.
$\cdot 016\ B\ X^2$ = cost per mile of wire.
$\cdot 0016\ B\ X^2$ = interest and depreciation at 10 per cent.
$\cdot 0016\ A\ B\ X^2$ = annual cost of wire (1).
$\frac{54,577}{X}$ = ohms per mile.
$\frac{54,577\ E^2}{X^2}$ = watts per mile.
$\frac{54,577\ E^2}{746\ X^2}$ = horse-power lost in transmission per mile.
$\frac{54,577\ C\ E^2}{746\ X^2}$ = cost of same.
$\frac{54,577\ A\ C\ E^2}{746\ X^2}$ = annual cost of power lost in entire circuit (2).

It is plain that with any increase in the size of wire the value of (1) will increase, while (2) will diminish, and the economical value of X will be such that the sum of (1) and (2) will be a minimum.

Let u = this sum:—

$$u = \cdot 0016\ A\ B\ X^2 + \frac{54,577\ A\ C\ E^2}{746\ X^2}.$$

$$\text{Differentiating, } \frac{du}{dx} = \cdot 0032\ B\ X - \frac{109,154\ E^2\ C}{746\ X^3}.$$

Placing this equal to zero, and reducing, we have

$$X^4 = \frac{45,700\ E^2\ C}{B}.$$

The formula shows that the diameter of wire depends on the price of copper, cost of power and quantity of current, and is entirely independent of the length of the circuit and the voltage. The differential coefficient shows that the formula is in harmony with Sir William Thomson's rule that "the additional running expense due to the resistance of the conductor shall equal the interest on its first cost." *Price of copper* refers to the bare wire without any covering or insulation whatever. The insulating cover is a mere matter of choice, like a brick, stone, or frame station.

Suppose water power can be furnished at Niagara Falls for ten dollars per horse-power per year and a ten-ampere current generated by this power be used for street lighting in Buffalo, the entire length of circuit being fifty miles, what is the economical size of line wired? A substitution in our formula gives X = 12) mils, equal to No. 8 B. and S., or exactly No. 11 Birmingham wire gauge.

* Paper read before the National Electric Light Association, August 8th, 1889.

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ELECTRIC RAILWAYS.*

BY G. W. MANSFIELD.

The application of electricity to street railways has been so rapid that we are liable to lose sight of many valuable points in our herculean efforts to supply the demand. The application of electricity during the past decade has been astonishing. For the transportation of the people in the streets of our towns and cities the demonstration has been witnessed, the application made, and a wonderful luxuriant growth started. Eliminate the horse-car from every city or town in the union and forecast the results. The horse-cars of the City of New York carry 199,491,735 passengers. If to this number are added those carried by the elevated roads, we have the total of 371,021,524, or almost as many passengers are carried in New York City alone as are annually carried by all the steam roads in the whole United States. The street railroads of the State of Massachusetts carry over 44,000,000 more people than all the steam roads in that State. One road alone, the West End of Boston, carries nearly 10,000,000 more than all the steam roads combined. To give you a rough idea of the size of an electric central station needed to operate all the cars. In New York City dynamo capacity of 13,800 horse-power would be demanded, in Boston 9,504 horse-power, and so on. This is destined to come as surely as the days succeed each other. In Boston it has come, and a station of approximately 8,000 horse-power is already in the hands of the engineers.

Electricity shows already the sturdy, vigorous growth that inevitably will result in its complete supremacy.

ELECTRIC STREET RAILROADS.

	1885.	1886.	1887.	1888.	Jan. 1—July 1, 1889.			Total.
					Operating	Building.	Total.	
Number of electric railways..	3	5	7	33	19	42	61	109
Number of miles of road	7·5	28	29	130·5	113	267	380	575
Number of cars.	13	39	81	265	174	364	538	936

The figures of the table certainly show that the facts warrant the prediction. They were most carefully prepared and include every road of any record. It does not show it all either. That remarkable contract which the West End Street Railway Company of Boston, the largest street railway company in the world, signed recently with the Thomson-Houston Electric Company is not included under the heading "roads building in 1889." I think that this contract in responsibility and importance is one of the greatest that has ever been signed in the history of electricity. In electric railroading it is the greatest and probably will be for many years to come. The West-End Street Railway Company, of Boston, owns 217 miles of track, and 1,584 cars, all of which are to be equipped so as to be operated with electricity. Add these to the list, and how does our list stand? If it be within the bounds of the supply men, at least 75 miles will be built this summer and 100 or more cars equipped.

In meeting this demand for better transit there are many considerations that claim our most careful attention. The conditions to be met are widely different from all other electrical applications. Essentially we have first, a steam engine; second, a dynamo; third, a conductor; and fourth, a motor mounted upon a vehicle, and subjected to mechanical and physical conditions more extreme and severe than ever heretofore has been imposed upon any piece of electrical machinery. In the battle for success the engine has to stand the bulk of the fighting. Anything wrong with it affects directly the electric system, and in many cases it also has to stand the blows if anything is wrong with the electrical system. The extreme liability of short circuits on the road from a variety of accidents that may happen on the very best roads render of the first importance that the engine have its main moving parts at least 20 per cent. heavier than ordinarily. Under the extreme fluctuations of load, keys, nuts and bolts will work loose. An engineer in a large station recently told me that he practically took to pieces and put together nearly every month a 100 horse-power engine running an 80 horse-power dynamo, whereas prior to the time that it had been connected to a railway dynamo it had given practically no trouble, although worked well to its capacity.

A compound engine rated at 109 horse power, running an 80 horse-power dynamo under test recently, gave the following:—

Friction card with dynamo, but no current, 11·65 horse-power.
Aggregate horse-power of cards, 1,247·74 horse-power.
Average horse-power of cards, 56·67 horse-power.
Maximum card, 120·79 horse-power.
Minimum card, 15·56 horse-power.

The cards were taken at 10 minute intervals for four hours. There were at the time three electric cars on the line, each towing another. As the day was a pleasant Sunday, every car was crowded. During the same time current and potential readings were taken on the line at the station. The average gave 30 horse-power, or an average efficiency of 54·6 per cent. for the total time. Every moment deducted that no current was flowing would raise this efficiency. At times the efficiency was far higher than this. The road conditions were severe, the grades ran as high as 10 per cent., and had numerous others of 5 and 7 per cent. The extreme current fluctuations were noted in one minute's variation from 45 amperes to 140. The potential was very constant. On another small road the extremes varied from the friction load to nearly 85 horse-power on an 100 horse-power engine. These extremes would happen even during the time a three-impression card was being taken. Under such conditions the questions of coal economy is a troublesome one. On large roads, unquestionably a far better showing would be possible. Laying aside the question of coal economy, which is cheap in comparison to food for horses, the best engine is the one that handles the average work with the least repairs. On some small roads the ratio of engine friction to average daily load may be large. The great majority of roads, however, will have a sufficient number of cars to so reduce the ratio of extremes to the average load that the engine can work at its most economical point of cut-off the major part of the time, and raise the average load to such a point above the friction load that the per cent. lost will be comparatively small.

If the following facts are known a fair judgment can be made as to how much electric power must be allowed per car, although I am much afraid that the accuracy of the judgment would not be that of a William Tell:—1. Number of cars simultaneously operated. 2. Speed and nature of service. 3. Maximum grade and number of grades. 4. Scheduled location of cars in reference to grades. 5. Motor cars to be used to tow other cars or not. 6. Any peculiarities in regard to the distribution of cars. 7. Condition of track. 8. Location of track in reference to power house.

A moment's thought over any one of those points, I think, will convince you of its importance. On a portion of the Cambridge division of the West End Street Railway Company's road, of Boston, the Thomson-Houston Company's motors commenced running February 16, 1889. Up to July 1, 165,781 miles and 25,505 round trips had been made with a loss of but 325 miles, or ·19 of 1 per cent., and 49 round trips, or the same per cent. of loss. During this time nearly 1,500,000 passengers were carried. This, in view of the fact that during the entire time one, and part of the time two, tow cars were drawn, is remarkable. It must also be known that the route extends over one of Boston's most crowded business thoroughfares, and is the main street connecting Cambridge and Boston. On a portion of the route there is an open bridge about 1,800ft. long, on which is located one draw, which is opened from 20 to 30 times a day. Over this bridge 1,810 cars per day pass, or on the average of one every three-quarters of a minute, and at some portions of the day they run at half-minute intervals. The teaming on this street is also very heavy, necessitating constant stopping. You will see from these figures what the loss of current or a motor burn out causing delay would mean. The record, however, has been magnificent. As the dynamos are run by the Cambridge Electric Light Company, and are so arranged that the same engines furnish power and lights for their own purposes, as yet only approximate data as to the fuel consumption, &c., has been possible. A few electrical tests have been made, as well as it were possible. Ammeter and voltmeter readings were taken at the stations every 15 minutes, four readings per minute, or at 15 second intervals. This was kept up from 6:30 a.m to 12:30 a.m. next morning for five days. In all, 1,480 readings were taken. The average of these readings gave for 12·6 cars in continuous service, 111·6 amperes, 500 volts, or 74·8 horse-power. Per car this is 8·8 amperes and 5·9 electrical horse-power. The average number of passengers carried was about 58 per round trip. We now have 32 cars in operation, and observations, in so far as they have been taken, show a marked decrease in horse-power per car. At Richmond, Va., some rough tests gave the electrical horse-power required per car at the station as from 4 to 5. On the road to Lafayette, Ill., the figures of Dr. Bell show the remarkable low figure of 2·5 electrical horse-power. There are a number of circumstances on this road that would tend to make this figure so low. The cars are smaller than those ordinarily used, and I should judge that there were other circumstances entering into the calculation that would tend to reduce it. However, it well shows, possibly, one extreme in railroading. The other extreme might be cited in the case of the Lynn road, Highland division. Here only one car is in operation. In the course of its route it ascends a hill graded at the rate of 8·7 per cent for 300ft., and immediately passes down on the other side. In this case the engine was indicated. Five cards were taken when the car was ascending the grade, the average of which was 52·2 horse-power. If we allowed a dynamo efficiency of 90 per cent., this would indicate an electrical horse-power of 47 horse-power. This is unquestionably a very extreme and exceptional case. I might add, incidentally, that the car pays handsomely. At Plymouth, Mass., a road having many heavy grades, the maximum being over 10 per cent., and operating but three electric cars, each with tow cars, the electrical horse-power at the station per car was approximately 7·72 horse-power. On the cars the extremes vary obviously according to speed, grades, load, &c. It frequently reaches from four to five times the average value during the total time. In Lynn the variation is enormous. In Cambridge the current frequently rises to from 65 to 70 amperes, or about 42 horse-power. Especially is this the case on starting. You can see from these figures the impossibility of giving only the most approximate figures in this direction unless every detail as to operation and conditions are known. I feel, however, that on roads having no grades over 5 per cent., and operating under 10 motor cars with tow cars, 15 horse-power per car would be a safe figure for dynamo capacity. On large roads this figure could be reduced to 12 and possibly 10 horse-power per car, while on small 3 or 5 car roads with heavy grades 18 or 20 horse-power might not be any too much. At Cambridge tests show that, of the total time consumed by a car in a round trip, it was taking power only 61·8 per cent. of the time, and that 6·7 per cent. of the total time the car was stopped. At Washington, where the streets were freer and not so thickly populated, the above figure for time when power was used rose to 66 per cent. Neither of these roads are what you might call large. It seems, however, that from 30 to 40 per cent. of power in excess of the absolute requirements can be planned for. I do not think, however, that this can be implicitly relied upon as in other power business, since there are many factors in the general operations of a railroad system that might at any moment tax the central station to its utmost.

In regard to total electrical and total commercial efficiencies, it is impos-

* Abstract of a Paper read at the meeting of National Electric Ligh Association, August 8, 1889.

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sible for me or anyone else to give accurate figures. There are so many fluctuating factors entering into such a determination, that, whereas a test made to-day would give me certain figures, a test made to-morrow, or a week later, would give me entirely different figures. The time factor must enter largely into such a test. From estimations based upon many figures, I feel certain that a total electrical efficiency of at least 70 per cent. can be obtained, and a total commercial efficiency measured from the indicated horse-power of the engine to the car wheel horse-power (W.H.P.) of from 45 to 50 per cent. If the road-bed, rolling-stock, and all the electrical apparatus is maintained as it should be, I see no reason why this figure cannot be exceeded.

There is one point which is of vital interest to the managers of electric light companies, and this is how they shall charge the railway companies for the power which they desire. I have already shown you that it is an exceedingly difficult thing to estimate upon the requisite power, as the conditions are so fluctuating and so variable. After, however, the question of the amount of power has been settled, the next point to determine is whether they shall charge the railway company by the hour, by the day, or by the car mile. We have a large number of roads already hiring power of local companies; all of the methods just mentioned are in use. Upon small roads where the schedule of the railway company is such that they have only a few cars running continuously, meeting emergencies by extras, and where the grades are heavy, a satisfactory basis has been to charge so much per day per car, the price ranging all the way from $3 to $5, $6 and even $7. When the roads are of moderate size, or are subject to many variations and sudden demands on the part of the public for better facilities, or when the line runs to some resort and the main bulk of business lay in picnics, &c., charges on the hour basis is sometimes preferred. This price varies from 15 to 30 cents per hour. On larger systems, where the schedule is definite and fixed, the mileage basis is the preferable by far. The prices on this basis range from two to six cents. You can readily see that if the cars ran at infrequent intervals, and if the morning and evening traffic was especially heavy and required a larger number of cars, while during the major part of the day only a few cars were out, the mileage basis would be quite unsatisfactory, since on the whole you would have to make steam possible for the maximum railroad output, and maintain it throughout the day. All of these estimates, however, can only be determined by knowing the local conditions and circumstances.

There are some 1,600 central electric light stations already located throughout the country, and some 425 railroad companies that sooner or later will be obliged to have electric power. Is there any reason why you should not do it? I know of many a station that has to stint and save to tide over the year's dull seasons. Here is an opportunity for still one more chance at profit. Railroads have an older and better standing in the financial world and on the money market than electric light companies. Can you afford to let the opportunity go by? From careful research, my own judgment would be that in many cases it would be the company's salvation.

A METHOD OF MEASURING THE COEFFICIENT OF SELF-INDUCTION BY MEANS OF THE TELEPHONE.*

The German Imperial Telegraph Department has been engaged in studying a practical method for measuring coefficients of self-induction which does not require a highly trained electrician to work it. The method is based on the Wheatstone bridge, a telephone being used instead of a galvanometer, and the apparatus used serves not only for the comparison of coefficients of self-induction, but also for determining their absolute value.

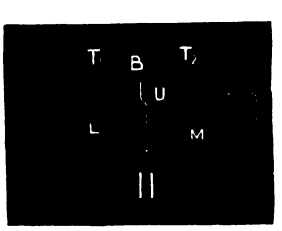

FIG. 1.

When the resistances T_1, T_2, M, L in the arms of the bridge (Fig. 1) have been adjusted to obtain a balance no current flows in B, and therefore this circuit may be opened or closed without affecting the currents in the rest of the system, and, consequently, if telephones are used for the resistances T_1, T_2, they will be silent on making and breaking contact at U.

Now, in using this method to measure self-induction, T_1 and T_2 (Fig. 2) are the coils of a differentially-wound telephone. The resistance of these coils is equal, and very great compared to the resistances of M and L, which are also equal to one another. The resistance of B is very small. A contact breaker is placed in the battery circuit, and B is permanently closed; the telephone will now emit a sound, unless the coefficients of self-induction of M and L are equal. These may be made equal in the following manner:—

* From *La Lumière Électrique*.

The two equal circuits of a double-wound coil S_1 are inserted in the arms T_1 and T_2, and opposite this double coil is a coil S, which is in circuit with the battery and contact breaker. The coils S and S_1 are mounted on the same support. S is fixed, while S_1 can be moved in the plane of S, and rotated about an axis in that plane. Now, the intermittent current flowing in S induces the same current in each half of S_1, and the intensity of it is proportional to the sine of the angle between S and S_1. Let us suppose that the coefficient of self-induction of L is greater than that of M. The action of M is partly neutralised by that of L, and the two coils, S and S_1, can be made to compensate the rest by suitable adjustment. If the coefficient of self-induction of M is very small, the value obtained by adjusting the coils S and S_1 is practically the coefficient of L.

By means of a galvanometer the calibration of the instrument and the measurement in absolute value of the coefficient of mutual induction between the coils S and S_1 are easily effected.

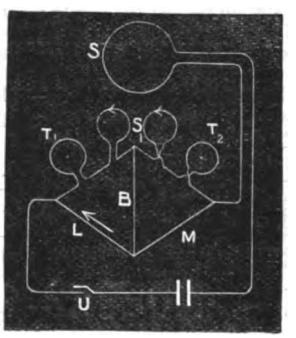

FIG. 2.

With an instrument constructed under the direction of Herr Stecker very good results have been obtained in the measurement of the coefficients of self-induction of steel and bronze wire. Iron wire does not give such a good result, for the telephone is never silent, and it is the least sound which has to be taken. An attempt has been made to measure the coefficient of self-induction of an iron wire forming part of the Berlin telephone system, but it has not given satisfactory results.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August* 17, 1889.

The National Electric Light Association has just held its tenth semi-annual convention at Niagara Falls, and the meeting appears to have been of a most interesting and successful character. The questions which come up before such a body are not strictly of a scientific nature, but there are a great many practical issues which have to be settled, and upon these the members threw themselves with a great deal of energy and sound common sense. Thus, for example, the Association has been quick to see that all this talk about the danger of electricity, and the legislation which proposes to inflict the death sentence by means of the electric current, is extremely hurtful to electrical industries as a whole, and it has determined to enter its protest against any measure which shall tend to turn the dynamo into an instrument of torture. The question of the constitutionality of execution by electricity was brought up at the Niagara Falls meeting by Mr. F. A. Wyman, a lawyer, of Boston, and Dr. Otto A. Moses, of this city, and after they had been heard on the subject, resolutions were adopted urging the Governor of the State to suspend sentence, and petitioning the State Legislature to repeal the electrical execution law. In the course of his remarks on the subject, Dr. Moses presented a number of interesting statements elicited by circulars sent to some 800 managers of electric light stations, and it would appear from these replies that the sensations experienced by those unfortunate enough to get a severe shock are of the most painful and distressing nature. Of 73 accidents occurring in central stations, 54 were due to the continuous-current and 19 to the alternating, and since in each of these cases a heavy current had not been strong enough to cause death but had given rise to dreadful sensations, it seemed fair to argue that in inflicting death, torture would be superadded in a way most repugnant to modern ideas of

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decency and humanity. It is hoped and believed that electrical execution has been removed from the list of punishments by this and similar action on the subject.

Another topic of general interest upon which the Association took action was with regard to abolishing the custom duty on copper ingots, wire, plate, sheet, bar, and rod. The resolution on this subject was presented by Mr. C. A. Brown, representing the Western Electric Company of Chicago, well known as one of the largest manufacturers of electrical apparatus in this country. It was seconded by Mr. G. M. Phelps, who stated it as his impression that copper entered into the cost of electric light plants in general to the extent of at least one-third, and perhaps more. It was endorsed by President Weeks, who, announcing himself from the chair as a Protectionist, said he believed this was a case in which we should protect ourselves, not against our foreign cousins, but against our home friends and relatives. The fact would appear to be that there is no advantage to any industry in the imposition of the copper tariff, and since everybody would be bettered by the supply of cheaper raw material, whether from abroad or from our domestic mines, the Association puts itself on record as desiring Congress to abolish the customs duty in question. Another interesting topic of large interest touched upon was that of the insurance of electric light plants. There has been a great deal of comment on the part of electric light men against insurance agents and companies, because good central stations have been lumped with bad, and the whole class rejected as an undesirable risk. The report presented by Mr. P. H. Alexander showed that 172 insurance companies had been paid premiums of over $41,000, on nearly three millions of insurance in 1888, while the losses collected during that year were less than $22,000, showing a gain to the insurance companies of $19,000. In the year following the amount of insurance in central stations was $3,000,000, the premiums received were $51,000 odd, and the loss was only $11,000, leaving a good balance to the insurance companies. Mr. Alexander drew attention to the work of the New England Insurance Exchange, which had issued a form describing a model electric light station which the Exchange guaranteed to insure at a very low rate; and the remarks of the insurance men on the matter, after the presentation of the report, went to show that the work of the Exchange, aided by the New England Electric Exchange, had resulted materially in raising the standard of central light station construction in New England. As Mr. Barton said:—"The work of perfection seems to have taken the strongest hold with us, and every electric light company that is contemplating building stations to-day is trying to do it in accordance with the standard which we have established, and some of them are even going past our standard." The committee in its report suggests the formation of an organisation within the Association for purposes of mutual insurance, but this idea did not seem to find general favour, on the ground that a thoroughly satisfactory station would be insured by the regular companies just as favourably as it would be by any mutual organisation, which, on the other hand, for its own sake, would have to be severe with stations that do not come up to its requirements.

Turning to Papers of a more technical nature, two that deserve note are those of Mr. M. D. Law, of Philadelphia, on the theoretically perfect arc-light station, and that by Mr. J. T. Henthorn and associate, on the new central station of the Narragansett Company, at Providence. Mr. Law's station at Philadelphia, of which the Paper gives a pretty good idea, does one of the largest electric light businesses in the country, and it is well known amongst electric lighting men here for the economy and efficiency with which it is carried on. The remarkable fact was brought out that Mr. Law had had two Corliss engines in his station which had been running steadily for 7 years, with a loss of only 10 minutes from trouble, and with an expense of only $25 for repairs. This is a remarkable statement, but nothing in the subsequent discussion tended to upset it, and it was realised that Mr. Law had made out a good case for the use of large slow-speed engines in central stations of the arc-lighting class. The Paper of Mr. Henthorn described what will be one of the finest arc-light stations in this country. Mr. Henthorn is in favour of running his station with large slow-speed engines, holding them to be more economical in the long run, in spite of their somewhat larger first cost. Perhaps the neatest criticism on this magnificent new station was that made by Mr. Kerr, a representative Westinghouse engine man, who said that the design was not sufficiently elastic. The station was a monumental piece of engineering work; but he did not think the time had yet come when we could build electric light stations as we did waterworks. There is some point in this comment, for as Mr. Kerr pointed out, electrical discoveries might be made very shortly which would seriously impair the utility of the station, and it would cost so much money to change it that it never could be changed. Yet, on the other hand, it is to be regarded as most happy that the time has come when electric light stations can be built on such a scale, and with such finish and refinement, for in this manner the development and growth of the business is perhaps brought more forcibly to the attention of capitalists and of the public than in any other. In connection with central stations also an interesting paper was read by Mr. C. C. Haskins, the electric light inspector of Chicago, who gave some point to the moral that incessant testing is the price of efficiency in central station apparatus. Mr. Benjamin Rhodes, of Niagara Falls, presented a neat little Paper on the economic size of line wire, in which he gave a method of calculation and developed the fact that the diameter of the wire to be used depends on the price of copper, the cost of power, and the quantity of current, being entirely independent of the length of the circuit, and, in this case, of arc-light currents of the voltage. The formula worked out agrees, too, with Sir William Thomson's rule for the most economical size of conductor, and with the contention of Deprez that the diameter is independent of the length of the circuit. Aside from the general interest attached to this little Paper a special interest was given to it by Mr. Rhodes using the Niagara Falls as an example. Supposing water power be furnished at Niagara Falls for $10 per horse-power per year, and a 10-ampere current generated by it, to be used for street lighting in Buffalo, the entire length of the circuit being 50 miles—25 miles each way—the economical size of line wire to be used would be No. 11, Birmingham, wire gauge, or about half the diameter of an ordinary lead pencil. This is a practical deduction that some of the members were not prepared for, as the general idea is that to transmit the power of the Niagara River to Buffalo would take a wire a great many sizes larger than that. Two interesting Papers were presented on street railway work, one by Mr. George W. Mansfield on the subject generally, and the other by Mr. William Bracken, speaking for storage batteries. Mr. Bracken called attention to the fact that the Julien cars on the Fourth Avenue-road were in successful operation, and that the number was being constantly added to. Mr. Mansfield presented a vast mass of most interesting statistics, in which he showed the rapid growth of electric railroads. He states that at the present time there are in this country 109 electric railroads operating and building, with 575 miles of track and 936 cars, whereas four years ago there were only three roads with seven miles and thirteen cars. These latest figures are exclusive of the enormous contract just made with the West End-street Railway Company of Boston, which, owning 217 miles of track and 1,584 cars, proposes to operate its whole system by electricity. The point that Mr. Mansfield made was that it was worth the while of electrical men all over the country to see what they could do to take part in the development of this industry. He figured out that in New York City to operate the street cars by electricity a dynamo capacity of 13,800 horse-power would be demanded, and in Boston 9,504 horse-power. This, he said, was destined to come as surely as the days succeeded each other; in Boston it had already come, as a station of approximately 8,000 horse-power for electric railway work was now in the hands of the engineers. He pointed also to the fact that there were now some 1,600 central stations throughout the country, and some 425 railroad companies, that sooner or later would have to use electric power, and he wanted to know why electric light men should not take hold of this business, and get their share of its returns, either by running independent stations for that class of work or by supplying the current. Supplementary to this topic was the resolution offered by Mr. Lynch, inviting the electric railway companies to standardise their potential as

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much as possible, so that there may be more uniformity in this respect than now obtains in the matter of lighting.

The quarrel between the Postmaster-General and the Western Union Company with regard to the rate of one mill per word, which it is proposed the Government should pay for its business is still going on, and Mr. Wanamaker and Dr. Norvin Green are exchanging excellent argumentative letters on the subject. The absurdity of the position of the Government is clearly shown in one fact, the statement of which renders it quite unnecessary to go further into questions of legality and constitutionality. If the Western Union Company were compelled to do the whole of its business at the rate that Mr. Wanamaker has attempted to fix for Government messages, its receipts for the year's work would be $257,320. The expenses of the Western Union Company during the average year are just short of $15,000,000, so that on Mr. Wanamaker's theory, the Government would have the right to make the Western Union Company spend $15,000,000 to earn a sum of only one-sixtieth of that amount. Mr. Wanamaker may talk as he likes about agreements under the Act of 1866, &c., but the logic of these figures is convincing.

New York City is at the present "torn up" and greatly agitated over the question of the World's Fair, which it is proposed to hold here in 1892, to celebrate the discovery of America by Columbus in 1492. It has been variously suggested to hold this exhibition at Washington, Chicago, St. Louis, and other places, but the choice is gradually narrowing down to New York City, and remarkable activity is being shown in preparing for the work. The Mayor of the city has invited the co-operation of a large number of well-known men, and has already appointed various committees to take action in making the preliminary arrangements. Various electrical bodies in this city are already up and doing, and each of these has a man to represent them on these committees. It seems probable that a representative will be allowed to each of the great electrical departments. The American Institution of Electrical Engineers is manifesting an early activity, and has already taken preliminary steps not only to assist in the great work, but to hold an international electrical conference in this city, taking up the work where the Paris conference may leave it. The co-operation of electrical bodies all over the country is to be invited, and there is no reason to doubt that the conference in 1892 will be one of the most interesting and useful of the series.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *August* 27, 1889.

On the 25th inst. the new telephone exchange in Prague was opened with a new and improved multiplex switch-board, made by Mr. Otto Schaffler in Vienna. The old boards were in use until five o'clock in the morning, and at 6.30 all the 615 subscribers were transferred to the new board. The whole of the new arrangement was installed whilst the old continued in service. At ten on the 25th the official opening of the new service took place. The Governor of Bohemia, the Burgomaster and Town Council of Prague, the Post Office head officials were present or represented, and were shown the new Exchange by the company's general manager, Mr. R. Howard Krause, and all expressed their delight and approval of the new arrangements.

In about a fortnight the new Government trunk line from Vienna to Prague will be completed, and the subscribers in Prague will then be able to speak to the subscribers in Vienna. The main line is already finished, and only the section through the town remains to be completed.

The Austrian and Hungarian Governments have finally come to an agreement with regard to a telephone line connecting Vienna and Budapest, a distance of over 150 miles, and work is to be commenced immediately, with a view to the wires being ready by the end of October. The Austrian Government will erect the line up to the river Leitha, while the Hungarian Government will complete it to Budapest. Three wires, two of which are to be reserved for Stock Exchange messages, will be run to begin with. The subscribers to the Vienna and Budapest exchanges will be able to communicate with one another direct, the price for three minutes' conversation being 1fl.

A Viennese electrician, Herr Capilleri, has obtained a concession for the electric lighting of the western faubourgs of Vienna. The site of the proposed central lighting station has been approved by the officials, and the work of construction has begun.

CORRESPONDENCE.

ALTERNATING MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The leaderettes in your issue of the 16th call for a reply from me; but as the post to the West Highlands is slow, I fear this letter will be too late for your next.

Before treating the various points in order, let me say that you appear to me to be trying to put a theory into my mouth, for which I am in no way responsible, and with which I do not agree. You appear to think I am an advocate of the curve of sine and constant co-efficient of self-induction method of treating motor problems. This is not the case at all. I regard such methods as a convenient for getting a rough result, but nothing more. I prefer to trace the action of the armature current on the field-magnets and pole-pieces, and not to assume a constant co-efficient of self-induction. The only excuse for including these reactions in the comprehensive but loose expression, "self-induction," is that it admits of the application of the curve of sine method to see roughly whether a motor will mote. The term "self-induction" has been often used in connection with direct-current machines to denote what I prefer to call the "back induction," or the demagnetisation of the field by the armature current. I have often objected to this term, and without wishing to insult anybody, I would suggest that the term was used in direct-current work only by those who did not really understand what takes place. Though one cannot reasonably talk of the back E.M.F. due to the self-induction of a direct-current armature, it may be permissible to call the "back induction" or the field demagnetisation of an alternator the "self-induction," and when you can get a rough approximation to truth by such an assumption, the curve of sines and constant coefficient method may be used. Of course in really thinking of the armature it is clear that its instantaneous coefficient of self-induction depends on what is going on outside it, that is, in the field magnets and pole-pieces.

Turning to your leaderettes and taking the points in order, I do not say "that the old theory of synchronism stands in need of no modification whatever," but that two machines of equal E.M.F. cannot run as dynamo and motor if the current at any instant is equal to the resistance divided by the algebraical sum of the E.M.F.'s; the machines would have in these positions an open circuit. That is to say, the machines cannot work unless the armature currents affect the fields, or unless, in other words, there is self-induction. I do not mean to say that the insertion of external self-induction has exactly the same effect as alteration of the fields. I do not see how the question of Dr. Hopkinson's infallibility comes in. He proved that with certain assumptions, admittedly only very roughly true, machines would run as dynamo and motor; and his conclusions are, roughly speaking, correct. From this people generally assumed that alternating motors were perfectly practicable if they could only be made to start. As far as I know I was the only writer who strongly urged that starting was only one difficulty, and that the efficiency at varying loads must be low. As I say, I do not know whether I was alone in this or not. I see from your note in the issue of August 9th, that M. Leblanc insists on the inefficiency of synchronising motors. I am taking a holiday now, and have not read the article itself. Mr. Mordey, of course, makes out that an alternating motor has the same efficiency as a dynamo even when designed for varying loads; that is, made so that its open circuit E.M.F. is equal to or greater than the generator or main E.M.F.

As to the statements of mine made between 1887 and 1889—which you now know to be hopelessly at variance with facts, and which resulted from my own, or at least the old, theory—I will take them in order:—

1. "That coreless armatures would only run parallel with no load." Such machines were supposed to have very small armature reaction, or very little self-induction. No doubt I, with others, have under-estimated this, but that is not a result of any theory of synchronisation. I must also point out that we are not at one as to what is meant by running in parallel. All these alternators have some tendency to synchronise. If ma-

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chines are at full load their armature loss is as high as is safe as regards heating. If they are out of step, due to one engine having more steam, so as to give greater torque, the armature loss is increased. What is required is to get the greatest corrective torque with the least extra armature heating. If the armature heating is great enough to cause trouble when the engines vary as much as they do in commercial work, the machines cannot work commercially in parallel. I believe that Mr. Ferranti has found this to be the case with his machines, but am not certain. I know of no case of such machines running in parallel. Of course, it must be borne in mind that the corelessness of the armature is in itself of no importance. The real question is whether the armature current can weaken the field of the motor or not. There is much more difference between a Zipernowski and a Westinghouse machine than between a Westinghouse and a Mordey.

2. "That with such armatures, it would be necessary to make up for the lack of self induction by putting iron elsewhere in the circuit." In such cases, I should still put artificial self-induction in the circuit; not "iron," but a "choking coil" which would probably contain iron.

3. I laid great stress on the "induction coupler," and still believe in it for keeping machines in parallel.

4. "That with a parallel constant E.M.F. system of supply, the use of such synchronising motors was incompatible with efficiency." This I still maintain. You say you know these conclusions are hopelessly at variance with facts; but how do you know that? Have you ever measured the virtual current of a parallel motor at full load? Of course, if the armature loss as a dynamo or resistance is, say, two per cent., the armature loss as a motor might go up to four or five per cent. without being easily traced in a rough experiment. The virtual current must be taken, to give an accurate result, and to give a fair comparison the total armature loss must be kept down to the value at full load on resistance. Vague statements that machines run well as motors without measurements of current are of no value.

5. "That such motors would not work well with varying load." An ordinary motor can be made to work well at full load by weakening the field till it is approximately cophasedly synchronised; but such a motor cannot have its load taken off, or it will lead and tend to short-circuit the mains. The armature loss will increase as the load is decreased unless the armature current now strengthens the field considerably. This form is, therefore, unavailable for varying loads; and resort must be had to a motor which at no load gives the same E.M.F. as the generator, or for safety, a very little more. Such a motor at full load has its current and back E.M.F. differing in phase, and is therefore inefficient, the armature loss being high in proportion to the output. It is here that, I take it, I differ from Mr. Mordey and from you.

Your next paragraph about the time-constant varying with the vibration frequency cannot be dealt with as it is vague. What is meant by Mr. Mordey's machines synchronising "equally well" at any "periodicity"? For example, two machines might be run at 100 volts and 1,000 revolutions, and at 100 volts and 500 revolutions, and might be arranged with similar fields in each case, or with one field slightly altered so as to get the same angular lag in each case. Or they may be run at 100 volts and 1,000 revolutions and 50 volts and 500 revolutions with equal fields or equal lag. Then how is the "equally well" measured, and what does it mean? Does it mean that the difference of torque is the same, or that the ratio of the difference of torque to the whole torque is the same, or that the virtual current, and therefore the armature loss, is the same? These general statements give no information. Until the alleged phenomenon is stated with some symptoms of scientific accuracy I cannot offer any explanation. I can only say that if the machines are in all cases running so fast that the field and pole-pieces do not vary their magnetisation perceptibly every half period, I should take L as constant. I should prefer not to take L at all. Your statement that L has been shown to be unchanged is misleading. You probably refer to some experiments with secohmmeters. I have already said that does not give you a value for L for a moving machine at full load, and I object to your trying to confuse by using such an obvious logical fallacy.

You next try to make out that I rudely controvert Sir William Thomson. This is not the case at all. Of course Sir W. Thomson's explanation is correct, but I still repeat that "most of the conclusions drawn from it must be reversed to have any meaning." In this experiment the motor field was strengthened and the dynamo weakened; in parallel work the motor field is weakened and the dynamo field strengthened. In the experiment the armature-current increases as the load decreases, in parallel work the reverse is the case. In the experiment the motor was leading, in parallel work it lags. Do you hold that it was generally understood, before I called attention to the fact, that the 2,000 and 1,000 volt experiment referred to a series motor and not to a parallel motor at all? As to contradicting people, if there is anyone whose opinion I generally respect, it is Mr. Mordey.

You go on to say that you do not so much differ as to my present interpretation of Mr. Mordey's experiments as to my assumption that I knew all that is to be known before. I do not see that my present interpretation is different from my past interpretation. Nor have I said that I knew all that was to be known. There is an irresponsible rashness of statement about your assertions that would adorn the pages of a society journal. Again, I am not crying down a new discovery. You here beg the question. I deny that Mr. Mordey has made any discovery. If he has, what is it? You also say I am illogical because I acknowledge I do not understand what Mr. Mordey's opinions are. If you say twice one is three I can controvert your opinion, without knowing how you prove it. All I need to do is to give my reasons for supposing the result to be approximately two. I have said clearly that the current and E.M.F. are not the same in phase in a parallel motor, therefore the armature loss is higher in proportion to the output than in a dynamo. Mr. Mordey denies this, but does not say how the motor works. You, as far as I can follow you, agree with Mr. Mordey, but you do not say either whether in a parallel motor the current and back E.M.F. are the same in phase, or how the motor can give the same efficiency if they are not.

Of course, any young fellow under fifty would forgive the bad taste of personal remarks about his extreme youth in view of the great value of fatherly advice from the venerable Nestor of Salisbury-court.—Yours, &c., JAS. SWINBURNE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the letter of mine which appeared in your impression of August 16th, obviously my remarks *re* the effect of iron in the armatures of alternate-current machines apply only to those machines which have either Pacinnotti teeth or projections around which the coils are wound, and not to those with a continuous smooth core, such as is used for a Gramme armature.—Yours, &c., W. B. SAYERS.

Lisbon, 20th August, 1889.

BOOKS, &c., RECEIVED.

"Technology Quarterly." Vol. II., No. 4. (Boston: Massachusetts Institute Technology).

"The E.P.S. System of Electric Supply." (The Electrical Power Storage Company, Limited).

"Proceedings of the Royal Society of Victoria." Vol. I. (New Series), June, 1889. (Melbourne).

"The School of Mines Quarterly." Vol. X., No. 4. (Columbia College, New York).

"Calendar for the Seventh Session." (University College, Dundee).

"Catalogue and Price List." (Messrs. W. H. Willcox and Co.)

"Proceedings of the Royal Society of Edinburgh." Vol. XVI., p. 193-256.

"Illustrated Electrical Catalogue." (Appleton, Burbey and Williamson.)

"Price List of Electric Light Cables and Wires." (The India Rubber, Gutta Percha, and Telegraph Works.)

"The A B C of Electricity." By W. H. Meadowcroft. (London: John Heywood.)

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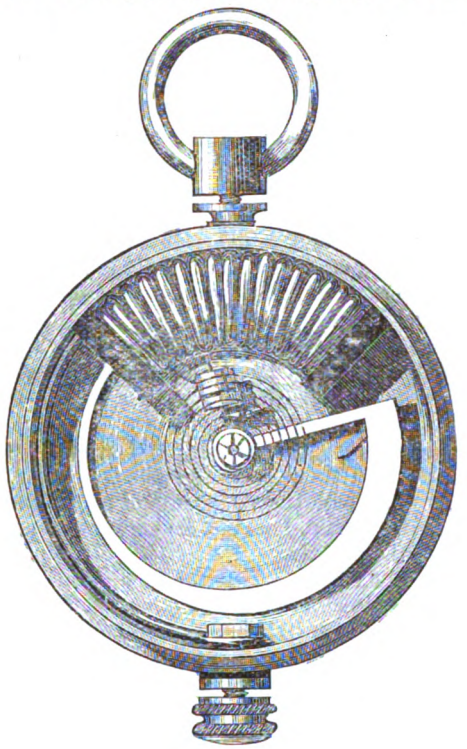
PORTABLE POCKET AMMETERS AND VOLTMETERS.

Some neat pocket ammeters and voltmeters have recently been brought out by Messrs. Mayfield and Co., of Queen Victoria-street. These instruments, which have been specially designed to meet the requirements of those engaged in electric lighting work, are shown in full size in the above cuts. The solenoid is wound on the segment of a circle, having for centre the centre of the case, and the core is tapered, so that the pull is very nearly proportional throughout, the opposing force being supplied by a delicate spiral spring. The pivots supporting the hands work in jewelled centres. The instruments are mounted in nickel-plated cases, and can be used in any position. The deflection for 1 volt or 1 ampere is about 50deg. in the smaller sizes, so that considerable accuracy can be obtained in the measurement of small currents. The ammeters are made in two types, one measuring currents up to 5 amperes, and the other currents of from 10 to 50 amperes. The voltmeters are made in three sizes, from 1 to 5 volts, 10 to 50 volts, and 20 to 100 volts.



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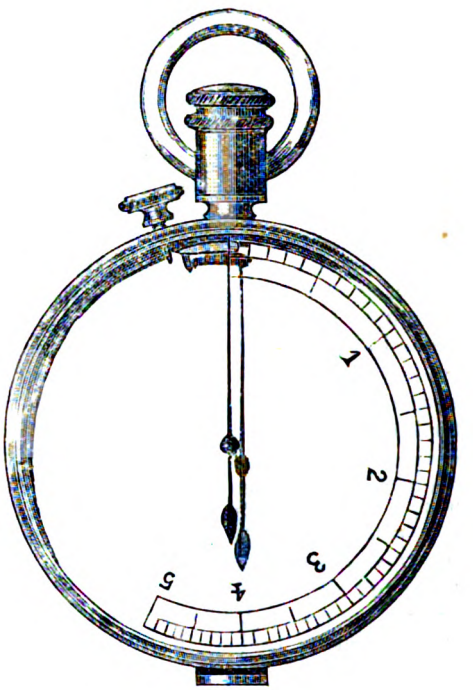

Front.

Mayfield and Co.'s Pocket Ammeters and Voltmeters.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

August 10, 1889.

12,647. G. C. Fricker. Putney. Improvements in alternate current dynamos.

12,659. T. B. Sloper. London. Improvements in or relating to mechanical telephones.

12,673. T. Field, Junr. London. The manufacture of electrical fabrics for curative purposes.

August 13, 1889.

12,731. W. P. Kookogey. Glasgow. A plate for secondary batteries.

12,752. H. G. Morris and P. G. Salom. London. Improvements in machines for filling secondary battery plates.

12,760. W. S. Salisbury. London. Improvements in electric motors for street cars.

12,772. A. De Castro. London. Improvements in means or apparatus for the generation and conversion of electric energy.

12,773. F. Wheeler. London. Improvements in the system of electric locomotion. (Date applied for under Patents Act, 1883, sec. 103, 14, January, 1889, being date of application in the United States.)

12,795. J. Kent. London. Improved means and appliances for feeding the carbons of arc lamps.

12,799. A. H. Chesnieu and F. B. A. Royer de la Bastie. London. Improvements in single fluid batteries.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
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BEARINGS, BUSHES,
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ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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August 14, 1889.

12,815. F. V. ANDERSON and J. O. GIRDLESTONE. Manchester. Improvements in electro motors.

August 15, 1889.

12,869. A. A. DAY. London. Improvements in apparatus for measuring electric energy.

12,901. R. E. B. CROMPTON. London. Improved means for supporting and separating the plates of electric accumulators.

12,903. R. JEWELL. London. Improvements in registering mechanism or counters actuated by electric currents.

August 16, 1889.

12,970. J. E. WRIGHT and J. MOORE. London. Improvements in printing telegraph instruments.

August 17, 1889.

12,982. T. BARTON. Blackburn. An improved motion for electrical switches.

12,998. C. WELLS. Middlesex. Improved electric apparatus for clocks.

13,001. H. DE POULPIQUET. Middlesex. Improvements in electric fire alarms.

13,011. F. SPERLING. London. Improvements in incandescent lamps.

August 19, 1889.

13,047. J. H. RIDER. Halifax. Improvements in arc lamps.

August 20, 1889.

13,149. T. PARKER. London. Improvements in apparatus for obtaining reciprocating motion from electric currents applicable to the operation of electric bells, hammers, caulking tools, or the like.

SPECIFICATIONS PUBLISHED.

1888.

10,437. WRIGHT and MOORE. Printing Telegraphs. (Price 11d.)

10,900. SIEMANN. Electric alarms for varying levels. (Price 6d.)

11,328. BOGGETT. Obtaining electricity. (Price 6d.)

11,963. SMITH. Electric rail or tramway systems. (Price 8d.)

12,290. SCHANSCHIEFF. Galvanic batteries. (Price 8d.)

13,078. GUERIN. Electric resistance meter and rheostat. (Price 8d.)

13,402. VARLEY. Secondary batteries. (Price 8d.)

13,615. SATTERLER. Electrical batteries. (Price 8d.)

13,621. DE FERRANTI. Electric meters. (Price 8d.)

13,643. SNELGROVE. Electric circuit making, &c. (Price 8d.)

13,717. ELOESSER. Electric batteries. (Price 8d.)

14,149. WILLCOX (Bradley). Dynamo electric machines, &c. (Price 8d.)

16,681. PATTEN. Multiplex telegraphs. (Price 1s. 1d.)

16,681A. PATTEN. Synchronizing electric motors. (Price 8d.)

17,123. MAYRHOFER. Electrically regulating clocks. (Price 8d.)

18,278. WILKINSON and HOLMES. Laying electrical conductors underground. (Price 8d.)

NEW COMPANIES REGISTERED.

THE ALCOY AND GANDIA RAILWAY AND HARBOUR COMPANY (LIMITED).—Registered by Ashurst, Morris, Crisp and Co., 6, Old Jewry, E.C., with a capital of 525,000 in £100 shares. Object, to take over, construct, acquire, equip, maintain, and complete works, railways, and harbours in the kingdom of Spain or elsewhere, and for such purposes take over, hold and exercise all or any of the rights, privileges, of any authority, concession or concessions, for the construction, equipment, and working of the same, and to enter into and carry into effect any contracts, and to maintain and work any other railways, tramways, electric or other power, telegraph and telephone lines and works, or other means of communication or appliances of a similar nature in the kingdom of Spain or elsewhere. There shall not be less than three nor more than five directors. Qualification, £500. The first to be appointed by the subscribers to the memorandum of association. Remuneration, £1,100, of which £300 shall be allowed to the chairman, and the balance divided among the other directors as they may determine.

STANHOPE WATER ENGINEERING COMPANY (LIMITED).—On the 17th inst. this company was registered, with a capital of £25,000, divided into 1,000 6 per cent. cumulative preference shares, and 4,000 ordinary shares, of £5 each. It proposes to enter into an agreement with J. S. Sawrey and Harrold Collet, for the acquisition of inventions relating to the supply or purification, softening, or filtration, of water, and for dealing with sewage, dye waters, refuse, or polluted water. Power is also taken to carry on the businesses of civil, mechanical, electrical and telephone engineers, and of chemists and contractors. The number of directors is not to be less than two, nor more than five. Qualification, £100 in shares. The company in general meeting will determine the remuneration.

CITY NOTES, &c.

BIRMINGHAM COMPRESSED AIR AND POWER COMPANY.—The ordinary half-yearly meeting of this company was held this week, and Mr. H. Wright, who presided, stated that the mains now laid, ranging from 24in. to 7in. in diameter, extended to four and a-quarter miles. Fourteen works were now supplied with power, and many more were negotiating. Their customers expressed complete satisfaction. He further stated that 5,000 clocks and 8,000 electric lamps derived their motive power from compressed air in Paris alone.

NATIONAL TELEPHONE COMPANY (LIMITED).—This company notify that their share register will be closed from 23th inst. until 2nd prox., both dates inclusive.

THE SCHMIDT-DOUGLAS ELECTRIC COMPANY.—An order for liquidation has been made in the estate of this company, electrical engineers, of Hustlergate, Bradford, and Mr. E. Musgrave (Messrs. B. and E. Musgrave, chartered accountants, Bradford) has been appointed liquidator. The total liabilities of the company are estimated at £30,000, of which about half are secured, and the creditors are said to be evenly divided among Bradford, Halifax, and London. The assets, consisting of freehold property, plant and stock-in-trade, are expected to realise about £30,000, the same amount as the liabilities. The company, we understand, has not contracted any large amount of bad debts. It was formed a few years ago, up to which time the business was carried on by Messrs. Schmidt and Douglas. Lighting stations have been established by the company in Leeds, Bradford, and Halifax. A block of buildings illuminated by electric light in Kirkgate, Bradford, is lighted by the company. A very important factor—and apparently the principal one—in bringing about the present position of affairs is, we understand, an action taken by an adjoining property owner, complaining that the works are a nuisance. It is not expected that the claims of the trade creditors will be large, and, as regards the firm's losses, the board of directors must necessarily sustain a considerable share, as they hold fully two-thirds of the undertaking. The petition for liquidation was presented by a small creditor, and the directors, after fully considering the state of affairs, decided that their more prudent course would be not to oppose the petition. The firm had obtained a fair amount of lighting work in Halifax, and this would probably have been largely extended in a very short time if certain conditions imposed by the Corporation could be modified.—*Glasgow Herald.*

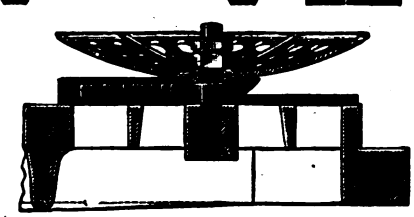
NOTICE OF REMOVAL.—The Telegraph Manufacturing Company, Limited, give notice that after September 1st their London office will be removed from 29, Queen-street, E.C., to Room 524, No. 11, Queen Victoria-street, E.C. Their head office and works remain at Helsby, near Warrington.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended August 23, 1889, amounted to £4,465.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 23, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,303.

NEW VALVE

No Rubber, Percha, or Leather.



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Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

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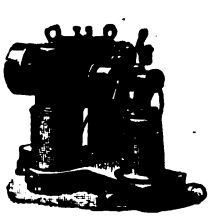
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Aug. 21, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Aug. 21, 1889.	
£					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
1,770,360	Stock	3%	Anglo-American	52 53	4 14 4	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	6%	Do. Preferred	88½ 89½	4 7 7	,, ,,	89⅝	88⅝
2,614,820	Stock	...	Do. Deferred	17⅜ 18⅛	...	February	18	17⅜
130,000	£10	10%	Brazilian Submarine	13 13½	5 18 6	Mar., June, Oct., Dec.	13¼	13
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9%	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10%	Do. Preference 10%	20 21	4 17 6	,, ,,	...	...
12,331	5	10%	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	...	...
6,000	5	10%	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3½%	Direct United States	10½ 10⅞	5 16 2	Jan., Apr., July, Oct.	10¹⅛	...
380,000	10	11/0	Eastern	13⅜ 13⅝	4 15 5	,, ,,	13⅝	13⅞
70,000	10	6%	Do. 6 per Cent. Preference	15½ 15⅝	3 16 2	,, ,,	15⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109⅜	109¼
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	5%	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅜	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	104	...
179,177	10	8%	Globe Telegraph and Trust	8⅜ 8⅝	8 7 3	Jan., Apr., July, Oct.	8⅝	8⅝
178,992	10	6%	Do. 6 per Cent. Preference	14⅝ 15⅛	3 19 4	,, ,,	14⅝	...
150,000	10	7½% for '88	Great Northern	15¼ 15⅝	4 15 3	Jan., July, and April	15⅝	15½
17,000	25	15%	Indo-European	40 42	6 1 6	April and October	42	41½
9,000	8	5%	Reuter's	6⅜ 7½	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	101 104	4 16 2	March & September	...	...
30,000	10	6% for '88	West Coast of America	10 10½	5 14 3	January and July	10⅝	10½
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2½ 2⅝	...	...	2⅝	2⅜
84,563	10	12/0*	Do. 1st Preference 6%	12 12⅜	...	April and October	12⅜	12
4,669	10	†	Do. 6 per Cent. 2nd Preference	14 15	...	...	15	...
45,181	15	6%	Western Brazilian	10⅜ 11½	6 10 4	March & September	11⅛	11⅛
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	100 102	5 17 8	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅛ ¼	4 8 3	...	...	...
55,000	5	3/0	United River Plate	5½ 5⅝	...	January and July	6¼	5⅝
			ELECTRIC LIGHT.					
23,003	5	...	Anglo-American Brush (£4 paid)	3½ 3⅝	...	...	...	...
23,692	5	...	Do. (fully paid)	4⅜ 4⅝	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	4¼ 4⅜	...	...	4⅝	4⅝
			MISCELLANEOUS.					
87,350	12	10%	Telegraph Construction and Maintenance	44 46	5 4 4	March and July	45¼	45
41,600	10	10%	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19⅝	19½

* Account arrears. † No dividend since May, 1890.



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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 590.—Vol. XXIII. FRIDAY, SEPTEMBER 6, 1889. Price Fourpence.

NOTES.

From an electrical standpoint it seems at present scarcely probable that the meeting of the British Association, which commences next week, will prove to be quite so interesting or important as that of last year. At Bath, in addition to a highly-remarkable series of Papers and discussions in Section A, we had at least five events of special interest to physicists generally—the Presidential Address of Sir Frederick Bramwell, the address of Prof. Fitzgerald as President of Section A, that of Mr. W. H. Preece as President of Section G, Prof. Ayrton's evening lecture, and last, though by no means least, the memorable discussion on Lightning Conductors. This year, under the presidency of Prof. Fowler, the Biologists will naturally occupy a leading position, and we understand that the meeting is being looked forward to with the highest interest by all workers in this great department of Science. The address of Capt. Abney, as President of Section A, will be devoted to Photography, and that of Mr. William Anderson to the Molecular Structure of Matter, chiefly with reference to the manufacture of steel. Meanwhile the only special arrangement which is likely to be made in connection with Section A—and even this has not yet been definitely concluded—is one for holding a joint meeting with Section C (Geological), in order to hear Prof. Rücker discourse on his and Prof. Thorpe's "Magnetic Survey of the British Isles." This will doubtless prove an attractive event for the members of both Sections, and although it will necessarily be devoid of that element of controversial excitement which characterised the joint discussion of last year, it may conceivably prove even more conducive to the extension of accurate knowledge.

With regard to the Papers on electrical subjects, which have been set down for Sections A and G, we are able to give a more complete account than any which has yet appeared, although in all probability the list will be still further extended between now and Wednesday next. In Section A, Prof. Ewing discourses "On the Magnetic Viscosity in Iron," and also "On Hysteresis in the Relation of Strain to Stress;" Mr. W. H. Preece has a Paper "On the Heating Effects of Alternate Currents upon Conduction of Different Metals;" Prof. S. P. Thompson has two Papers, one "On Sparkless Electro-Magnets," and one "On a Phenomenon in Electro-Chemical Solution of Metals;" Prof. Oliver Lodge reads a Paper "On the Failure of Metal Sheets to Screen off the Electrostatic Effect of a Moving Charge;" Prof. James Blyth has "A New Form of Current-Weigher;" Prof. Schuster has a short Note "On the Discharge of Electricity through Gases;" Prof. H. Stroud reads a Paper "On the E.M.F. Produced by Abrupt Variation of Temperature at the Point of Contact of two Portions of the same Metal;" Drs. J. H. Gladstone and J. Perkins have a Paper "On the Correspondence between the Molecular Refraction, Dispersing, and Magnetic Rotation of Carbon Compounds;" Mr. J. Swinburne, either here or in Section G, will read a Paper "On the Design of Transformers." Finally, Prof. W. F. Barrett will read the Report of the Committee "On the Magnetisation of Iron."

In addition to the above programme we may confidently anticipate one or more electrical Papers, both from Sir William Thomson and from Lord Rayleigh, although the subjects have not yet been announced. We may also hope to hear, either from Dr. Lodge or from Mr. Glazebrook, some results of an important character, which they have recently worked out together in the Cavendish Laboratory. There will also be one or two exhibits. Mr. J. Edmundson will show a New Electric Current Meter, and Mr. Murday an Apparatus for Reading Indications of Distant Meteorological Instruments.

Turning to Section G, we find that the electrical features of the programme are at present somewhat of the briefest, and although the Papers set down, if we may judge from the titles, should be by no means devoid of interest, yet (as, indeed, is usually the case in Section G) there is little to be looked for in the way of absolute novelty. Mr. W. Webster will read a Paper "On the Electrical Treatment of Sewage;" Mr. J. Swinburne one "On Dynamos," and Mr. E. C. Manville one "On the Northfleet Electric Tramway." Mr. Killingworth Hedges will also discourse "On the Distribution of Electricity by Underground Mains," Mr. W. H. Preece has promised a Paper on a subject not yet communicated, and Prof. Forbes may possibly have something to say on electric launches.

The Special Committee of the Board of Electrical Control of the City of New York which was appointed in connection with the recent explosions in the electrical subways has now presented its report. The Committee is of opinion that in every case the explosions have been due to the presence of coal gas, and where no obvious means of ignition existed upon the spot it is suggested that the actual point of ignition may have been at some distance and that the flame was carried backwards along

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the subway. With regard to the available means of obviating this serious difficulty, it appears that the engineers of the Subway Construction Company have found it absolutely impossible to make their ducts air-tight, and the only successful method of ventilation which has yet been attempted consists in maintaining an air pressure throughout the system. This device not only ensures ventilation but excludes the gas which would otherwise leak into the tubes. The Committee is of opinion that the responsibility rests entirely with the gas companies, and call upon them to make their service pipes air-tight. For our own part, whilst fully agreeing with these recommendations, we still feel it to be a little hard upon the gas companies, who are called on to do what the engineers of the subways profess themselves absolutely incapable of accomplishing. Meanwhile have we any grounds for believing that the London gas mains are in any better condition? If not, how are similarly unpleasant results to be obviated in this country?

Our New York correspondent furnishes us with a very interesting account of the proceedings at the annual Convention of the Edison Illuminating Companies which has just been held at Niagara Falls. It is significant to learn that the Edison General Electric Company has at length fully recognised the imperative necessity for some method of distribution capable of extension over a greater radius than that of the existing three-wire system. This question has for some time past led to considerable complaint and uneasiness amongst the local Edison companies, who are, of course, quite unable to compete with the alternate-current transformer for long-distance lighting, and who have frequently had to sit idly by whilst their competitors have swept the adjacent districts. The representatives of these companies, therefore, received with gratification the announcement that the General Company were in a position to supply continuous-current transformers for use in sub-stations; these machines will be wound for 1,000 to 1,200 volts on the primary circuit, and the largest sizes would have an output of 640 amperes on the secondary. It has been known for a long while past that Edison was anxious to develope the continuous-current transformer, but the fact that his machine is immediately ready for the market is somewhat of a surprise.

It is, however, still more surprising to learn (according to the New York *Electrical World*), that the Edison Company has so far "climbed down" that it is now actually willing to supply on demand an alternate-current transformer service. The speech in which Mr. Jenks announced this concession is quite a curiosity in its way. We quote from the report of the *Electrical World*:—

"The admissions of the warmest friends of the alternating systems, at the recent National Convention, of the terrible danger attending their use, as exemplified by the horrible tortures which have been undergone by innocent victims, and the selection by the State of this current (of the standard of 1,000 volt-potential) as an embodiment of the most deadly force known to science for the execution of criminals, all point to a very limited application of this form of apparatus. It is especially noteworthy that the dangers attending its use will shortly influence legislation, as a matter of protection to life and property. But the demand for an alternating system being recognised, it is now proposed to offer one of the most efficient type at its actual value, as being dangerous and inefficient at best, but procurable on demand."

It will be interesting to observe whether the local companies, now that the door is thus grudgingly opened, will be chiefly influenced in their choice of plant by the success of their rivals or by the appalling terrors of the alternating system which Mr. Jenks, with so much gusto, displays.

Now that Edison has gone into the alternating business, it clearly rests with him, if he be at all careful of his reputation as Inventor *par excellence*, to give us an entirely novel and successful alternate-current motor. To doubt his ability to do so would be as heinous a crime as "to speak disrespectfully of the Equator."

In our issue of December 23rd, 1887, we described and illustrated a novel and ingenious type-printing telegraph instrument which delivered its matter in column form, instead of on the well-known tape. This apparatus was the invention of Mr. F. H. Higgins, of the Exchange Telegraph Company; it was the outcome of several years of study and experiment; and we have every reason to believe that it was absolutely the first of its kind. By a singular coincidence, however, on December 22nd, 1887 (the day before we published the description of Mr. Higgins' perfected instrument) a specification was filed by Messrs. Wright and Moore describing an instrument of the same class, and this has since been followed by later patents covering various improvements on the original design. We draw attention to these facts for the reason that there now lies before us the prospectus of the "Column Printing Telegraph Syndicate (Limited)," whose avowed object is to raise the modest capital of £5,000 in order to enable it to enter upon litigation with the Exchange Telegraph Company with a view to test the validity of their patents. Apart from the somewhat questionable character of this proceeding, there are several statements in the prospectus which, to say the least, seem to require elucidation. What, for instance, in view of the facts just stated, are we to understand by the allegation that Messrs. Wright and Moore's instrument "accomplishes electrically a result which hitherto it has only been possible to achieve mechanically by means of the type-writer?" As to the probable result of the threatened litigation we are not called upon to express an opinion, though we may remark that the unquestionable priority of Mr. Higgins' patent, and the careful drawing of the claims, would seem to render its invalidation a matter of some considerable difficulty.

The negotiations between the French Government and the Telephone Company for the transfer of the property of the latter not having been brought to a satisfactory issue, the Government took possession of the service, on Sunday last, *manu militari*. At ten o'clock twelve State engineers, each attended by a police commissary, took over the twelve central offices of the Telephone Company, each and every one of whose officers in charge protested against what they termed a confiscation, declaring they submitted only to main force. By special permission of

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the President of the Tribunal of Commerce, twelve *huissiers* were detached to the company's offices in order to serve proper legal notices of the protest on the representatives of the Government. This writ specifies, amongst other things, that the company has not been paid the indemnity of the transfer, nor has any arrangement even fixed the amount, and, furthermore, that the offices, apart from the wires, instruments, and plant, belong to it by right of regular leases which have not been conveyed to Government. The dispute will in all probability be fought out in the Courts. The Government, we may add, have appointed their own arbitrators to assess the amount of the indemnity, and have refused to allow the company to appoint a second one on their own behalf. The desire to have the telephonic system of the company under Government control when the forthcoming general election takes place is said by the French press to be the chief reason for the extinction of the Société des Téléphones.

THE activity displayed in the Strand by the METROPOLITAN ELECTRIC SUPPLY COMPANY has caused some surprise, inasmuch as the work of laying underground mains was commenced before their Provisional Order was even so much as confirmed by Parliament, and therefore before the expiration of the month's notice to the local authorities which the Act requires. We understand, however, that this apparent precipitation was due to an arrangement with the Vestry, who were anxious to have the work done at the same time as the repaving of the Strand.

THE companies who are now at work on their mains are the METROPOLITAN ELECTRIC SUPPLY COMPANY and Messrs. GATTI, in the Strand, and the ST. JAMES' AND PALL-MALL COMPANY, in Piccadilly. The ST. JAMES' COMPANY, which, it will be remembered, is working under a License dated December, 1888, is using bare copper strip conductors, run on china insulators, in flat-shaped iron troughs. Messrs. GATTI, who, we may remark *en passant*, have so far dispensed with the formality of a Provisional Order, are running their cables in Callender-Webber conduits, the asphalte casings of which are protected from mechanical injury by thin iron sheets. The METROPOLITAN COMPANY run their high-tension cables from the Sardinia-street Station in 6in. iron pipes, positives and negatives together. With regard to the LONDON ELECTRICITY SUPPLY CORPORATION, along the lines of railway between Deptford and Charing Cross their mains have for some time been completed, and the Grosvenor Gallery machines will very shortly be relieved of a considerable portion of their load. We may take this opportunity to contradict a rumour—which seems to have attained a wide circulation—to the effect that this Company had decided to reduce their primary potential from 10,000 to 5,000 volts. The statement has no foundation in fact.

IN the concluding paragraph of the last article headed "M. Leblanc on Alternating Motors," in a recent issue, there is a curious suggestion for converting the period of an alternating current in any required ratio. The mathematical theory of this device may be left as an appropriate exercise for third-year students, but (since the article was in print) we have taken the trouble to plot out some of the curves which are given by the transformed current; the results are curious. In the case where the period is shortened, the curve of the impressed E.M.F. is much distorted. But the effect of attempting to lengthen the period is quite different, and, indeed, if our examination be sound, it would appear that M. LEBLANC is in error in supposing that it can be done at all. In fact, when the speed of the commutator is one-half that of the poles, the impressed E.M.F. takes the form of two successive half-periods, say of + sign, followed by two half-periods of − sign, and so on. It is obvious that the device can only be worked at all with multipolar connections for the field, otherwise the necessary speed of the commutator would be prohibitive at normal frequencies. In a recent conversation with Mr. SHALLENBERGER we gathered that the same end has been attained in the Westinghouse Laboratory by purely inductive methods without moving parts.

THE fact that the possession of an Electric Lighting License carries with it certain stringent obligations as well as certain privileges has scarcely dawned as yet upon the CORPORATION OF DUBLIN, otherwise they would not have wasted several hours in a wrangling discussion as to whether or not mains should be laid in certain streets of the city. The penalty of failing to do this, and to do it within a specified time, is simply the revocation of the License.

The Birmingham Exhibition.—On Saturday, 24th ult., over 10,000 persons were admitted to the Exhibition, the attendance being the largest since the opening.

The Metropolitan Electric Lighting Schemes.—The Royal Assent was given on Friday last to the Electric Lighting Provisional Orders (Nos. 2, 3, 4 and 5) Bills.

Geelong.—The office of the *Geelong Times* is now lit throughout by the electric light. The installation was carried out by Messrs. A. U. Alcock and Co., of Melbourne.

The Annual Meeting of the Iron and Steel Institute.—The meeting of the Iron and Steel Institute takes place in Paris on the 24th inst., and a large attendance of members is expected.

The Vevey-Chillon Electric Railway.—During the engineers' *fête* at Vevey, which took place at the beginning of August, the Vevey-Chillon Electric Railway carried over 50,000 passengers.

Baroda.—The installation at the Gaekwar of Baroda's new palace was recently inaugurated. Several members of the Bombay Corporation were present at the invitation of Messrs. Siemens Brothers.

Newcastle (New South Wales).—The Secretary of Public Works states that it is the intention of the Government to light the wharves of Newcastle by electricity, and tenders will shortly be called for.

Catalogue of Engineers' Stores.—We have received from Messrs. W. H. Willcox and Co. their useful catalogue of engineers' stores. This firm manufactures a special oil for gas engines, which has met with considerable favour.

University College, Bristol.—The 1889-90 Session of this College begins on October 9th. The course of electrical engineering includes laboratory work and dynamo testing. Further particulars will be found in our advertisement columns.

Telephony at Porto Rico.—Tenders will be received up to the 30th September, 1889, at the Ministry of the Colonies, Madrid, from persons willing to contract for the installation and working for 20 years of the telephonic service of the city of Porto Rico.

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Electric Railway Plant for Russia.—An order for the whole of the material for some electric railways to be laid along the courses of certain rivers of Northern Russia, which are frozen during six or seven months of the year, has been secured by a Belgian firm.

The Electric Light at the British Museum.—Preparations for the installation of the electric light in the various parts of the British Museum not at present provided with it are rapidly progressing. It is anticipated that when the main collections are illuminated a large increase of popular attendance will be secured.

The Electrical Exhibition at St. John's.—At the opening of this exhibition a cannon was fired by means of an electrical current from Vancouver, over 3,000 miles distant, and a small paper entitled the *Electric Era* was set up and published two editions daily in the exhibition building, the press being run by an electric motor.

Competitions for 1890.—The Société d'Encouragement has recently published the programme of the competitions for the year 1890. Amongst the prizes is one of 2,000fr. for the best domestic motor, to work by itself or in connection with a central station; and one of 3,000fr. for a method of long-distance transmission of energy.

Catalogue of Messrs. Appleton, Burbey and Williamson.—This is a well illustrated little catalogue containing full particulars of the numerous varieties of switches, switchboards, fuses, and fuseboards made by this firm. Messrs. Appleton, Burbey and Williamson also make a speciality of acid-proof linings for battery boxes.

Tenders Wanted.—The Municipal Council of Sydney, New South Wales, are advertising for tenders for lighting the streets, &c., by electricity. Further particulars will be found in our advertisement column, and all information can be obtained at the offices of the Agent-General for New South Wales, 9, Victoria-street, Westminster, S.W.

The Proposed Pacific Cable.—The Committee appointed recently by the San Francisco Chamber of Commerce to investigate the feasibility of laying an ocean telegraph cable from that port to Australia has reported in favour of the project, and estimates the cost of a cable line to New Zealand by way of Honolulu and Tutuila at £2,000,000.

Bradford.—The arrangements for the supply of electric light in Bradford are now practically complete. The engines have been thoroughly tested, and all the apparatus, with the exception of some minor fittings at the generating station in Bolton-road, is ready for use. The inauguration of the station will take place about the middle of this month.

An Electrical Prize.—The committee charged with examining the papers sent in in connection with the prize of 25,000fr offered last year by the King of the Belgians for the best work concerning industrial applications of electricity, has just been nominated. It is composed of Sir William Thomson and MM. Montefiore, Cornu, Roïti, Kittler, Gérard, and Ponthière.

Edinburgh and the British Association.—It has been resolved by the Town Council of Edinburgh to request the governing body of the British Association to hold next year's meeting or that of 1891 in that city. As may be remembered, the meeting of the Association in 1871 was held in Edinburgh, on which occasion Sir William Thomson was the president.

Aberdeen.—On Monday last the Town Council received a report from the Gas Committee recommending that a special meeting should be held on 7th October for the purpose of considering the propriety of applying to the Board of Trade for a Provisional Order under the Electric Lighting Acts. The recommendation of the committee was adopted.

Royal Victoria Hall.—On Saturday last this admirable institution reopened as the first People's Palace for South London. Next week there will be a dioramic entertainment relating to the Paris Exhibition, and on the first Thursday in October the ballad concerts will re-commence. The programme for the winter promises to be as full of interest and variety as ever.

The Edinburgh Exhibition.—At a meeting of the Executive Committee held last week it was announced that Sir William Thomson and Mr. W. H. Preece had been added to the list of vice-presidents. The deputation which had been sent to Paris to see Mr. Edison reported that the arrangements with Mr. Edison were nearly completed, and that they had also arranged for the transfer of a number of interesting exhibits at present on view in Paris.

Reading.—We learn that the electric light station in Reading is now supplying more lamps than the plant was originally intended to serve; and owing to the increased demand for the light by business firms, Messrs. Laing, Wharton and Down have arranged for a considerable addition to the plant. This is entirely independent of the street lighting, about which the Town Council have not taken any steps to carry out the resolution passed at their meeting in June last.

Electric Lighting at Higham Ferrers.—A correspondent informs us that a novel combined heating and lighting apparatus has been introduced into Higham Ferrers by Mr. Ambrose Marriott. This apparatus is so arranged that it can be instantly converted into a steam boiler for driving the engine and dynamo in connection with the electric light with which the works and private residence are lighted. The dynamo is a compound one of Laurence, Paris and Scott's make.

Solar Radiations and Electric Phenomena.—According to a recent Paper by M. Albert Nodon, solar radiations, if they encounter an insulated conductor (metal or carbon), communicate it to a positive charge. The magnitude of this charge increases with the intensity of the sunlight, and decreases with the hygrometric state of the air. The phenomenon ceases if clouds pass before the sun. Solar radiations, therefore, M. Nodon thinks, may be one of the causes of the electrification of clouds.

Northampton.—The prospectus of the Northampton Electric Light and Power Company has just been issued. The Directors are all well-known business men of the locality. A site has been obtained in Angel-lane for the works, and it is proposed to arrange for an immediate distribution of electricity to various parts of the town. It is intended in the first instance to put down a plant capable of supplying 14,000 lights at an estimated cost of about £19,000. From promises already received it is anticipated that 8,500 lights will be quickly taken up.

Loughborough.—At the last monthly meeting of the Town Council, the Mayor, in moving the adoption of the General Purposes Committee minutes, said, with regard to the communication from the Midland House-to-house Electricity Company, he thought they should first of all consider the company which had come, or was going to come, into their midst—the Brush Electrical Engineering Company. He thought he was only speaking the general feeling of the whole Council that they should give any privileges to that company if they had any to give.

Machine Driving by Electricity.—This is the title of an illustrated popular pamphlet published by the United Electrical Engineering Company. The numerous virtues and advantages of the electric motor are dwelt on at considerable length, and the special suitability of electricity for mines, pleasure launches, light railways, and naval work, is clearly shown. The claims of the telpherage system are also succinctly set forth. Pamphlets of this description should go a long way towards familiarising the public with the idea of utilising electricity as a motive power.

Price List of Electric Light Leads.—The price list of electric light cables and wires issued by the India-Rubber, Gutta-Percha and Telegraph Works is an excellent publication, both as regards arrangement and typography. The various cables are clearly grouped together according to the nature and degree of their insulation, and in separate tables are given full particulars respecting the diameter, weight and resistance of the different sizes of conductors. The cables made by this firm are all tested at a pressure of 450 volts after 24 hours' immersion in water at 60°F., so that the insulation may be relied upon.

The Dynamos on Board H.M.S. "Hercules."—The *Standard* correspondent on board the "Hercules," writing of the occurrences in the manœuvres, says:—"A little later the dynamos

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from the search lights collapsed. If this had happened half an hour earlier, it might possibly have meant the sinking of the ship. I find that this mishap occurred in exactly the same way last year, and that it is due to the flimsy manner in which these machines are fastened to the deck. It would be better, I should think, not to fit appliances of this kind at all to old vessels, if they are liable to fail at any critical moment."

Sales by Auction.—Wednesday, September 18th, has been fixed for the sale, by Messrs. Wheatley Kirk, Price and Goulty, of the contents of Crown Works, Hackney, N.E. The same firm announce the sale, on the 24th September, of a large assortment of high-class machine tools and engines, at St. George's-circus, Borough-road, London, S.E. Mr. Scamell announces the sale, on the 17th inst., at 47, Holborn-viaduct, E.C., of a large quantity of electroliers and other fittings, being the London stock of Winfield's (Limited). Further particulars of Messrs. Wheatley Kirk's sales will be found in our advertisement columns.

Norwich.—At the last meeting of the Town Council, Mr. Squirrell moved that it be an instruction to the Electric Lighting Committee to inquire whether the fall of water at the New Mills could be utilised for the purpose of lighting the streets or any part thereof, and if so, to what extent, and what it would cost to carry on such work. He said the New Mills were now tenantless, and he believed the Water Works Company were willing to give up their lease of them to the city for a comparatively small amount. The opportunity had arisen for acquiring the mills, and if they were of any use for the production of electric light for the open spaces of Norwich, it ought not to be neglected. The motion was carried.

Belfast.—At the monthly meeting of the Corporation, on Monday last, the Gas Committee, in an appendix to their report, stated that they were of opinion that the time had arrived when the Council should obtain powers to supply electric light within the city, and they recommended that they should be authorised to apply for a Provisional Order for that purpose. The Mayor said the action of the Gas Committee had been forced upon them by recent applications for permission to erect plant in the city on the part of two or three English electric lighting companies. It was evidently undesirable that they should be allowed to anticipate the Corporation in a matter of that kind. At the same time, he did not think there was any cause for alarm with reference to their gas works, and he did not anticipate any interference with its prosperous career. The report was adopted.

The Compressed Air System in Paris.—In spite of the admirable conclusions of M. Van Rysselberghe with regard to the distribution of power by the compressed air system, this method of distribution (says *l'Electricien*) does not seem to prove very successful. The Popp Company itself is on the point of abandoning the system, and six steam-engines are at this moment being put up in the Rue Boissy d'Anglas. Perhaps the idea is to make up by this means the loss sustained up to the present in working the compressed air system, although the charge for a horse-power hour was rather high. Every horse-power hour furnished by the motor required three cubic metres of air at 1½ centimes the cubic metre; and when we add that the indications of the metre were multiplied by a certain factor (3, 12, or 13, according to circumstances) we get an approximate idea of what the cost of this so much vaunted compressed air really was. *Sic transit gloria* . . . of compressed air.

The Recent Thunderstorms.—There was a storm of considerable severity on Monday and Tuesday, chiefly in the home counties, doing great damage to property. At Hayford the lightning struck the silk-printing works of Messrs. D. Evans and Co.; the buildings caught fire, and damage to the extent of £10,000 was done. Some old cottages in the London-road, at Crayford, were struck, as well as several large elms, large portions of them being torn off and the trees split in all directions. At Northumberland Heath, the Builders' Arms was struck by lightning, the chimney-stack knocked down, and the roof damaged. Sheerness and the Isle of Sheppey were visited by a storm which lasted four hours, the vivid flashes of lightning illuminating the country for miles round. The house of Mrs. Walford, at Seal, Chart, was struck by lightning and completely burned out, the inmates having a narrow escape. It is stated that the damage done will not be less than £3,000. A very heavy thunderstorm broke over Dover early on Tuesday morning. Two vessels lying in the harbour and another in the bay had their masts struck and splintered by lightning. The storm was also severely felt at Deal, and a considerable number of telephone wires were damaged. Several sheep at Sutton Valence were killed by the lightning. Ford Croft, the residence of Mr. Thomas Plummer, Orpington, was struck by lightning, and completely wrecked. Several buildings near Faversham were struck by lightning. At Way-street a farm roof was partly stripped. At Graveney a cottage chimney was demolished. Some stables at Shepherd's-hill Farm, Sheldwich, and at Shottenden, were struck and partly unroofed, as was a farm-house near Whitstable. The storm raged over a great part of Essex throughout the night. At Brentwood some farm buildings near the town were struck by lightning and set on fire. At Rochford Hall, the residence of Mr. C. Tahor, some outbuildings were struck by lightning and ignited. Four farmsteads were fired by lightning in the neighbourhood of Braintree, great damage being done in every case. Some fine trees at Audley End and Stansted Park were struck by lightning, and a stack was set on fire at Sutton. During Monday night a heavy thunderstorm broke over Mid-Northamptonshire. At Old Duston, two miles from Northampton, a house was struck and partially destroyed. During a severe thunderstorm at Tralee, on Tuesday morning, a young man was killed by lightning.

Dublin.—At the meeting of the Corporation on Monday last Mr. Robinson, C.E, Chairman of the special committee on electric lighting, moved the adoption of a report of that committee recommending that application be made for sanction to the borrowing of £50,000 to carry the scheme into effect, and also that the committee be empowered to acquire a site other than Island Bridge. The report stated that the committee proposed to apply the system of illumination, in the first instance, in the lighting of the streets and premises from Nelson's Pillar to St. Stephen's-green, and through Dame-street, Parliament-street, Grattan Bridge, Mary-street, and Henry-street. Very valuable information had been received by the committee from other towns, but before finally deciding on the plan and estimates, a sub-committee, accompanied by the Town Clerk and the Borough Surveyor, visited various installations in which success appeared to have been obtained. Mr. Robinson urged the importance and value of electric lighting, and pointed out the advantage it would be to have the station down at Sir John Rogerson's quay, for they would there have coal at their doors, and they could avail themselves of the new system by which sewage was disposed of by the aid of electricity. They would be saved the enormous expense of sending out the sewage of Dublin to the Nose of Howth. Mr. Gill opposed the adoption of the report, because he believed that electric lighting would result in a loss to the city. —Mr. J. B. Healy did not think that such important thoroughfares as Westmoreland-street, Grafton-street, Dame-street, and other important thoroughfares in the city of Dublin should be left as they were as regarded lighting while it was in their power to adopt a much more improved system. The people of Dublin were in favour of electric lighting.—Alderman Meagher pointed out that if the Corporation did not undertake the electric lighting of Dublin, private companies were ready and anxious to step in and derive the profits to which the citizens were entitled.—The Lord Mayor said if the Corporation of Dublin waited in taking steps in this matter the ground would be occupied by somebody else. Of course there would be a risk, but not a great one, and there might be a loss for a time. The repayment of a loan of £50,000, interest and principal, would mean a penny in the pound, while the gas bill amounts to fivepence in the pound. He believed the ratepayers of Dublin were quite willing to run the risk, and he believed they would be well advised in doing so if they only had the two objects in view, that of cheapening the gas and increasing the facilities of the undertaking of the gas works by the Corporation.—The motion was then adopted by 38 to 3 votes.

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THE PARIS EXHIBITION.

The Edison Electric Company.

The Edison Company have dispensed with the usual oil-cups on their dynamos, and adopted a somewhat novel method of lubrication. It will be best understood by inspection of the sketches, Figs. 1 and 2. The armature spindle, S, runs in ball bearings, of which one is shown at B, Fig. 1, in elevation. This rests on soft metal and has a slight amount of play for adjustment. The supports, shown in section with the cover removed, are made to contain oil, OO, which is continually poured over the shaft by the following simple contrivance:—A groove is cut near each end of the bearing, and the upper half is entirely cut away down to the shaft. A light copper ring, C, of V-shaped section, is slipped over each end and dropped on

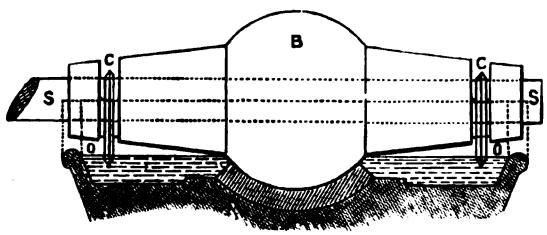

Fig. 1

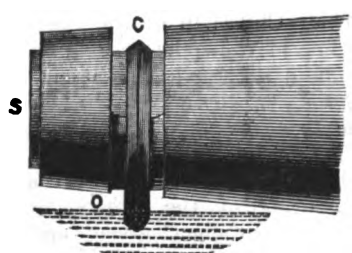

Fig. 2.

to the shaft. As the latter revolves the rings roll round on it, gathering oil as they do so, and pouring it over the shaft. The arrangement has had a good test during the past few months in the Palais des Machines, where dust is plentiful, but the machines run easily for six weeks or more without fresh oil or further attention.

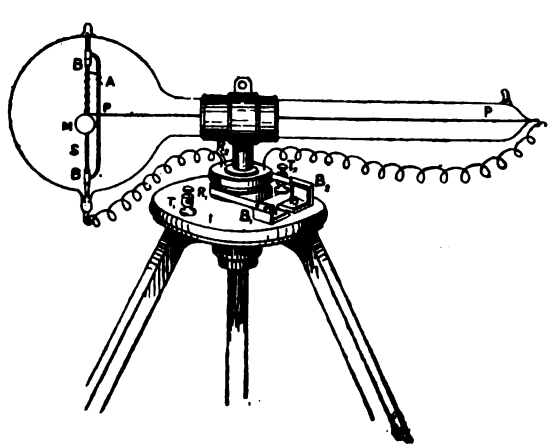

Fig. 3.—Edison Dead-Beat Mirror Galvanometer.

Most of the apparatus and instruments exhibited by this company are too well known to need detailed description, but among the physical apparatus is a dead-beat mirror galvanometer, the general construction of which will be understood from Fig. 3.

It does not seem to have been made in large numbers, but has been used considerably in Mr. Edison's laboratory since 1879. It works by means of a fine platinum silver wire, which expands when heated by the current. This wire, PP, is fixed at one end and wound round a small spindle, S, at the other; it is then passed through a small hole in S and attached to the metal support A, so that it acts like a spring and controls the action. The mirror M is attached to the spindle S, which moves in light bearings, BB. These parts are all enclosed in a glass receiver like a long-necked incandescent lamp, and the air is exhausted. The receiver is then fixed into a holder so constructed as to allow of its being turned round for adjustment, and the whole is mounted on an insulating table, I, fixed to a brass tripod with a levelling screw to each leg. A current on entering at one of the terminals T_1 would pass to the brush B_1, with which it is in contact, thence to the insulated ring R_1, and along one of the flexible connections into the receiver; it would then flow along the wire PP, and leave by the other flexible wire, reaching the upper insulated ring R_2, thence to the brush B_2 and terminal T_2. We need scarcely add that its "figure of merit" is hardly comparable with that of a Thomson galvanometer; it is, in fact, only intended for use with heavy currents. It could, however, be employed for alternating currents, and would possess many of the advantages with which we are familiar in the Cardew voltmeter.

REVIEWS.

Communications faites a la Societe Francaise de Physique et de la Societe Internationale des Electriciens, par Albert Bandsept; Articles extraits de diverse revues scientifique sur les Accumulateurs Electriques. (Cie. Imprimerie Belge, Bruxelles.)

This little pamphlet, as its lengthy title indicates, is a collection of Papers relating to secondary batteries, some by M. Albert Bandsept, civil engineer, of Brussels, others extracted from "L'Année Électrique," "Bulletin Technologique Mensuel," &c.

The articles which will justly attract the most attention are those which refer to M. Bandsept's own work in the improvement of the secondary battery. In his researches he devoted special attention to the physical influences which are manifested during the discharge. He endeavoured to determine the particular kind of molecular structure which best favours the maximum amount of electro-chemical action. The improved plates introduced by M. Bandsept are very highly spoken of, and the results of his experiments also seem to afford a novel solution of certain problems referring to the depolarisation of primary cells. It will be remembered that M. Bandsept first reduces the lead to a condition of the finest attainable subdivision, and then again compresses the metal into a solid plate, thus obtaining a material which, whilst apparently homogeneous, is in reality more or less of a porous nature.

The relative advantages of the various modifications of the original Planté battery are discussed and compared, and in the same Paper are diagrams showing sections of the plates used in the Faure-Sellon-Volckmar, the Somzée and Gadot systems.

Perhaps the most interesting article, from a strictly scientific point of view, is that in which the theory of electrolysis is carefully discussed, and this is illustrated with some ingenious and instructive diagrams, showing the molecular movements and changes which the author supposes to occur during the various stages of the process.

With regard to the capacity of accumulators it has often been stated that whatever may be the system employed the capacity per given weight is practically the same. Hence arises the question whether there is any use in trying to improve in this direction. The above statement is criticised by M. Bandsept, and the question seriously examined.

"Accumulators must be considered and compared not merely from the point of view of their absolute capacity, but in reference to their relative power for doing work in a given time."

M. Bandsept considers that there is every good reason for continuing to prosecute research on the accumulator in order to raise its power-value. He points out and enlarges upon the difficulties which are in the way, gives reasons why so many

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have failed, and indicates very clearly the direction in which he believes the solution of the problem will ultimately be found.

Apart from the special interest attached to a description of M. Bandsept's own discoveries, these Papers form a valuable contribution to our knowledge of secondary batteries, and may be thoroughly recommended to those electricians who make a special study of this subject.

THE MODERN THEORY OF LIGHT.*

BY PROF. OLIVER LODGE.

To persons occupied in other branches of learning, and not directly engaged in the study of physical science, some rumour must probably have travelled of the stir and activity manifest at the present time among the votaries of that department of knowledge.

It may serve a useful purpose if I try and explain to outsiders what this stir is mainly about, and why it exists. There is a proximate and there is an ultimate cause. The proximate cause is certain experiments exhibiting in a marked and easily recognisable way the already theoretically predicted connection between electricity and light. The ultimate cause is that we begin to feel inklings and foretastes of theories, wider than that of gravitation, more fundamental than any theories which have yet been advanced; theories which, if successfully worked out will carry the banner of physical science far into the dark continent of metaphysics, and will illuminate with a clear philosophy much that is at present only dimly guessed. More explicitly, we begin to perceive chinks of insight into the natures of electricity, of ether, of elasticity, and even of matter itself. We begin to have a kinetic theory of the physical universe.

We are living, not in a Newtonian, but at the beginning of a perhaps still greater Thomsonian era. Greater, not because any one man is probably greater than Newton,†, but because of the stupendousness of the problems now waiting to be solved. There are a dozen men of great magnitude, either now living or but recently deceased, to whom what we now know towards these generalisations is in some measure due, and the epoch of complete development may hardly be seen by those now alive. It is proverbially rash to attempt prediction, but it seems to me that it may well take a period of fifty years for these great strides to be fully accomplished. If it does, and if progress goes on at anything like its present rate, the aspect of physical science bequeathed to the latter half of the twentieth century will indeed excite admiration, and, when the populace are sufficiently educated to appreciate it, will form a worthy theme for poetry, for oratorios, and for great works of art.

To attempt to give any idea of the drift of progress in all the directions which I have hastily mentioned, to attempt to explain the beginnings of the theories of elasticity and of matter, would take too long, and might only result in confusion. I will limit myself chiefly to giving some notion of what we have gained in knowledge concerning electricity, ether, and light. Even that is far too much; I find I must confine myself principally to light, and only treat of the others as incidental to that.

For now well-nigh a century we have had a wave-theory of light; and a wave-theory of light is quite certainly true. It is directly demonstrable that light consists of waves of some kind or other, and that these waves travel at a certain well-known velocity, seven times the circumference of the earth per second, taking eight minutes on the journey from the sun to the earth. This propagation in time of an undulatory disturbance necessarily involves a medium. If waves setting out from the sun exist in space eight minutes before striking our eyes, there must necessarily be in space some medium in which they exist and which conveys them. Waves we cannot have unless they be waves in something.

No ordinary medium is competent to transmit waves at anything like the speed of light; hence the luminiferous medium must be a special kind of substance, and it is called the ether. The *luminiferous* ether it used to be called, because the conveyance of light was all it was then known to be capable of; but now that it is known to do a variety of other things also, the qualifying adjective may be dropped.

Wave motion in ether, light certainly is; but what does one mean by the term wave? The popular notion is, I suppose, of something heaving up and down, or perhaps of something breaking on the shore in which it is possible to bathe. But if you ask a mathematician what he means by a wave, he will probably reply that the simplest wave is

$$y = a \sin (p t - n x),$$

and he might possibly refuse to give any other answer.

And in refusing to give any other answer than this, or its equivalent in ordinary words, he is entirely justified; that *is* what is meant by the term wave, and nothing less general would be all-inclusive.

Translated into ordinary English the phrase signifies "a disturbance periodic both in space and time." Anything thus doubly periodic is a wave; and all waves, whether in air as sound waves, or in ether as light waves, or on the surface of water as ocean waves, are comprehended in the definition.

What properties are essential to a medium capable of transmitting wave motion? Roughly we may say two—*elasticity* and *inertia*. Elasticity in some form, or some equivalent of it, in order to be able to store up energy and effect recoil; inertia, in order to enable the disturbed substance to overshoot the mark and oscillate beyond its place of equilibrium to and fro. Any medium possessing these two properties can transmit waves, and unless a medium possesses these properties in some form or other, or some equivalent for them, it may be said with moderate security to be incompetent to transmit waves. But if we make this latter statement one must be prepared to extend to the terms elasticity and inertia their very largest and broadest signification, so as to include any possible kind of restoring force and any possible kind of persistence of motion respectively.

These matters may be illustrated in many ways. but perhaps simple loaded lath or spring in a vice will serve well enough. Pull aside one end, and its elasticity tends to make it recoil; let it go, and its inertia causes it to overshoot its normal position; both causes together cause it to swing to and fro till its energy is exhausted. A regular series of such springs at equal intervals in space, set going at regular intervals of time one after the other, gives you at once a wave motion and appearance which the most casual observer must recognise as such. A series of pendulums will do just as well. Any wave-transmitting medium must similarlypossess some form of elasticity and of inertia.

But now proceed to ask what is this Ether which in the case of light is thus vibrating? What corresponds to the elastic displacement and recoil of the spring or pendulum? What corresponds to the inertia whereby it overshoots its mark? Do we know these properties in the ether in any other way?

The answer, given first by Clerk Maxwell, and now reiterated and insisted on by experiments performed in every important laboratory in the world, is:—

The elastic displacement corresponds to electrostatic charge (roughly speaking, to electricity).

The inertia corresponds to magnetism.

This is the basis of the modern electro-magnetic theory of light. Now let me illustrate electrically how this can be.

The old and familiar operation of charging a Leyden jar—the storing up of energy in a strained dielectric—any electrostatic charging whatever—is quite analogous to the drawing aside of our flexible spring. It is making use of the elasticity of the ether to produce a tendency to recoil. Letting go the spring is analogous to permitting a discharge of the jar—permitting the strained dielectric to recover itself, the electrostatic disturbance to subside.

In nearly all the experiments of electrostatics etherial elasticity is manifest.

Next consider inertia. How would one illustrate the fact that water, for instance, possesses inertia—the power of persisting in motion against obstacles—the power of possessing kinetic energy? The most direct way would be to take a stream of water and try suddenly to stop it. Open a water-tap freely and then suddenly shut it. The impetus or momentum of the stopped water makes itself manifest by a violent shock to the pipe, with which everybody must be familiar. The momentum of water is utilised by engineers in the "water-ram."

A precisely analogous experiment in electricity is what Faraday called "the extra current." Send a current through a coil of wire round a piece of iron, or take any other arrangement for developing powerful magnetism, and then suddenly stop the current by breaking the circuit. A violent flash occurs if the stoppage is sudden enough, a flash which means the bursting of the insulating air partition by the accumulated electro-magnetic momentum.

Briefly, we may say that nearly all electro-magnetic experiments illustrate the fact of etherial inertia.

Now return to consider what happens when a charged conductor (say a Leyden jar) is discharged. The recoil of the strained dielectric causes a current, the inertia of this current causes it to overshoot the mark, and for an instant the charge of the jar is reversed; the current now flows backwards and charges the jar up as at first; back again flows the current, and so on, charging and reversing the charge with rapid oscillations until the energy is all dissipated into heat. The operation is precisely analogous to the release of a strained spring, or to the plucking of a stretched string.

* Being the general substance of a lecture to the Ashmolean Society in the University of Oxford, on Monday, 3rd June, 1889. [Reprinted from the *Liverpool University College Magazine*.]

† Though, indeed, a century hence it may be premature to offer an opinion on such a point.

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But the discharging body thus thrown into strong electrical vibration is embedded in the all-pervading ether, and we have just seen that the ether possesses the two properties requisite for the generation and transmission of waves—viz., elasticity, and inertia or density; hence, just as a tuning-fork vibrating in air excites aerial waves or sound, so a discharging Leyden jar in ether excites etherial waves or light.

Etherial waves can therefore be actually produced by direct electrical means. I discharge here a jar, and the room is for an instant filled with light. With light, I say, though you can see nothing. You can see and hear the spark indeed—but that is a mere secondary disturbance we can for the present ignore—I do not mean any secondary disturbance. I mean the true etherial waves emitted by the electric oscillation going on in the neighbourhood of this recoiling dielectric. You pull aside the prong of a tuning-fork and let it go: vibration follows and sound is produced. You charge a Leyden jar and let it discharge: vibration follows and light is xcited.

It is light just as good as any other light. It travels at the same pace, it is reflected and refracted according to the same laws; every experiment known to optics can be performed with this ethereal radiation electrically produced, and yet you cannot see it. Why not? For no fault of the light; the fault (if there be a fault), is in the eye. The retina is incompetent to respond to these vibrations—they are too slow. The vibrations set up when this large jar is discharged are from a hundred thousand to a million per second, but that is too slow for the retina. It responds only to vibrations between 4,000 billions and 7,000 billions per second. The vibrations are too quick for the ear, which responds only to vibrations between 40 and 40,000 per second. Between the highest audible and the lowest visible vibrations there has been hitherto a great gap, which these electric oscillations go far to fill up. There has been a great gap simply because we have no intermediate sense-organ to detect rates of vibration between 40,000 and 4,000,000,000,000,000 per second. It was, therefore, an unexplored territory. Waves have been there all the time in any quantity, but we have not thought about them nor attended to them.

It happens that I have myself succeeded in getting electric oscillations so slow as to be audible. The lowest I have got at present are 125 per second, and for some way above this the sparks emit a musical note; but no one has yet succeeded in directly making electric oscillations which are visible, though indirectly everyone does it when they light a candle.

Here, however, is an electric oscillator which vibrates 300 million times a second, and emits etherial waves a yard long. The whole range of vibrations between musical tones and some thousand million per second, is now filled up.

These electro-magnetic waves have long been known on the side of theory, but interest in them has been immensely quickened by the discovery of a receiver or detector for them. The great through simple discovery by Hertz of an "electric eye," as Sir W. Thomson calls it, makes experiments on these waves for the first time easy or even possible. We have now a sort of artificial sense-organ for their appreciation—an electric arrangement which can virtually "see" these intermediate rates of vibration.

The Hertz receiver is the simplest thing in the world—nothing but a bit of wire or a pair of bits of wire adjusted so that when immersed in strong electric radiation they give minute sparks across a microscopic air gap.

The receiver I have here is adapted for the yard-long waves emitted from this small oscillator; but for the far longer waves emitted by a discharging Leyden jar an excellent receiver is a gilt wall-paper or other interrupted metallic surface. The waves falling upon the metallic surface are reflected, and in the act of reflection excite electric currents, which cause sparks. Similarly, gigantic solar waves may produce auroræ; and minute waves from a candle do electrically disturb the retina.

The smaller waves are, however, far the most interesting and the most tractable to ordinary optical experiments. From a small oscillator, which may be a couple of small cylinders kept sparking into each other end to end by an induction coil, waves are emitted on which all manner of optical experiments can be performed.

They can be reflected by plain sheets of metal, concentrated by parabolic reflectors, refracted by prisms, concentrated by lenses. I have at the College a large lens of pitch, weighing over three hundredweight, for concentrating them to a focus. They can be made to show the phenomenon of interference, and thus have their wave length accurately measured. They are stopped by all conductors and transmitted by all insulators. Metals are opaque, but even imperfect insulators such as wood or stone are strikingly transparent, and waves may be received in one room from a source in another, the door between the two being shut.

The real nature of metallic opacity and of transparency has long been clear in Maxwell's theory of light, and these electrically produced waves only illustrate and bring home the well-known facts. The experiments of Hertz are in fact the apotheosis of that theory.

Thus, then, in every way Maxwell's 1865 brilliant perception of the real nature of light is abundantly justified; and for the first time we have a true theory of light, no longer based upon analogy with sound, nor upon a hypothetical jelly or elastic solid.

Light is an electro-magnetic disturbance of the ether. Optics is a branch of electricity. Outstanding problems in optics are being rapidly solved now that we have the means of definitely exciting light with a full perception of what we are doing, and of the precise mode of its vibration.

It remains to find out how to shorten down the waves—to hurry up the vibration until the light becomes visible. Nothing is wanted but quicker modes of vibrations. Smaller oscillators must be used—very much smaller—oscillators not much bigger than molecules. In all probability—one may almost say certainly—ordinary light is the result of electric oscillation in the molecules of hot bodies, or sometimes of bodies not hot—as in the phenomenon of phosphorescence.

The direct generation of *visible* light by electric means, so soon as we have learnt how to attain the necessary frequency of vibration, will have most important practical consequences.

Speaking in this University, it is happily quite unnecessary for me to bespeak interest in a subject by any reference to possible practical applications. But any practical application of what I have dealt with this evening is apparently so far distant as to be free from any sordid gloss of competition and company promotion, and is interesting in itself as a matter of pure science.

For consider our present methods of making artificial light; they are both wasteful and ineffective.

We want a certain range of oscillation, between 7,000 and 4,000 billion vibrations per second; no other is useful to us, because no other has any effect upon our retina; but we do not know how to produce vibrations of this rate. We can produce a definite vibration of one or two hundred or thousand per second; in other words, we can excite a pure tone of definite pitch; and we can demand any desired range of such tones continuously by means of bellows and a keyboard. We can also (though the fact is less well known) excite momentarily definite etherial vibrations of some million per second, as I have explained at length; but we do not at present seem to know how to maintain this rate quite continuously. To get much faster rates of vibration than this we have to fall back upon atoms. We know how to make atoms vibrate; it is done by what we call "heating" the substance, and if we could deal with individual atoms unhampered by others, it is possible that we might get a pure and simple mode of vibration from them. It is possible, but unlikely; for atoms, even when isolated, have a multitude of modes of vibration special to themselves, of which only a few are of practical use to us, and we do not know how to excite some without also the others. However, we do not at present even deal with individual atoms; we treat them crowded together in a compact mass, so that their modes of vibration are really infinite.

We take a lump of matter, say a carbon filament or a piece of quicklime, and by raising its temperature we impress upon its atoms higher and higher modes of vibration, not transmuting the lower into the higher, but superposing the higher upon the lower, until at length we get such rates of vibration as our retina is constructed for, and we are satisfied. But how wasteful and indirect and empirical is the process. We want a small range of rapid vibrations, and we know no better than to make the whole series leading up to them. It is as though, in order to sound some little shrill octave of pipes in an organ, we are obliged to depress every key and every pedal, and to blow a young hurricane.

I have purposely selected as examples the more perfect methods of obtaining artificial light, wherein the waste radiation is only useless, and not noxious. But the old-fashioned plan was cruder even than this; it consisted simply in setting something burning; whereby not the fuel but the air was consumed, whereby also a most powerful radiation was produced, in the waste waves of which we were content to sit stewing, for the sake of the minute—almost infinitesimal—fraction of it which enabled us to see.

Everyone knows now, however, that combustion is not a pleasant or healthy mode of obtaining light; but everybody does not realise that neither is incandescence a satisfactory and unwasteful method which is likely to be practised for more than a few decades, or perhaps a century.

Look at the furnaces and boilers of a great steam-engine driving a group of dynamos, and estimate the energy expended; and then look at the incandescent filaments of the lamps excited by them, and estimate how much of their radiated energy is of real service to the eye. It will be as the energy of a pitch-pipe to an entire orchestra.

It is not too much to say that a boy turning a handle could, if his energy were properly directed, produce quite as much real light as is produced by all this mass of mechanism and consumption of material. There might, perhaps, be something contrary to the laws of nature in thus hoping to get and utilise some specific kind of radiation without the rest, but Lord Rayleigh

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has shown in a short communication to the British Association at York that it is not so, and that therefore we have a right to try to do it.

We do not yet know how, it is true, but it is one of the things we have got to learn.

Anyone looking at a common glow-worm must be struck with the fact that not by ordinary combustion, nor yet on the steam-engine and dynamo principle, is that easy light produced. Very little waste radiation is there from phosphorescent things in general. Light of the kind able to affect the retina is directly emitted; and for this, for even a large supply of this, a modicum of energy suffices.

Solar radiation consists of waves of all sizes, it is true; but then solar radiation has innumerable things to do besides making things visible. The whole of its energy is useful. In artificial lighting nothing but light is desired; when heat is wanted it is best obtained separately by combustion. And so soon as we clearly recognise that light is an electrical vibration, so soon shall we begin to beat about for some mode of exciting and maintaining an electrical vibration of any required degree of rapidity. When this has been accomplished, the problem of artificial lighting will have been solved.

ON SOME MECHANICAL DETAILS OF ELECTRICAL MACHINERY.*

BY A. J. SHAW.

In the practical application of electrical machinery to heavy work, more failures have resulted from lack of sufficient attention to mechanical details of construction than from any other single cause, if not more than from all other causes combined. Many electricians have never learned to look upon electrical machinery as anything more than laboratory apparatus. This may be due to the fact that they are scientific experimenters and not mechanics. This is not universally the case, however, for that some are fine mechanical as well as electrical engineers is shown by the character of their work.

In designing dynamos and motors for heavy duty a liberal margin should always be allowed for overloading, abuse, and neglect, not only in the electrical portion of the apparatus, but in all the mechanical details as well.

Brushholders in which the brushes are held in place by small nurled head-set screws; binding posts and flimsy connectors in or to which still more unsubstantial screws are expected to secure large conductors, are things which one would hardly expect to find on dynamos and motors from reputed first-class makers; but one does find them, nevertheless.

Screws for connections should have square or hexagonal heads in all cases when possible, and set and binding post screws should have heads of the same shape. Screws requiring too frequent adjustment to make the use of a wrench undesirable should have liberal "wing" heads, or heads with cross pins. Nurled heads are an abomination, and should never be used on heavy machinery under any circumstances.

Screws to which connections are made by twisting the wire around them should be especially substantial, and should in all cases be provided with liberal washers.

In many engineering establishments it is one of the unwritten rules never to use a set screw less than, say, $\frac{3}{8}$, or a bolt less than $\frac{1}{2}$ or $\frac{5}{8}$ of an inch in diameter, except by "special dispensation." Even when the nominal load on the bolt is such that it might be carried by one that is much smaller, it has been found the only safe way to allow a liberal margin for contingencies—such, for instance, as a burly labourer at the end of a monkey wrench. Similar rules, modified as to the sizes of the bolts and screws to be used, should apply to heavy electrical work.

The "factor of safety" has been called a "factor of ignorance." It should sometimes be based on the ignorance of the user.

A motor, designed specially for very heavy duty in a situation where anything more than the most ordinary care was not to be expected, was provided with connectors having $\frac{3}{16}$in. slot-headed brass screws for securing conductors of No. 4 A.W.G. wire. It is, perhaps, superfluous to state that some of these screwed themselves off instead of in, and had to be replaced with screws of iron.

Not only are liberally-proportioned screws less likely to get broken, twisted off, or otherwise crippled, than the imitation fastenings often furnished, but better contacts, and consequently less trouble from heating, as well as a higher electrical efficiency, are obtainable, as the larger screws can be set down hard enough to exert a reasonable degree of pressure.

There is a motor in the market, the brush-holders of which are pitted with brass screws about $\frac{3}{16}$ of an inch in diameter, with nurled heads about $\frac{5}{8}$ of an inch in diameter. One of these screws is supposed to be sufficient to clamp the brush securely in place. It did hold for a short time, when the brush slipped, was readjusted, and soon slipped again. This time a persuader was applied, in the shape of a pair of pliers, and the brush did not slip again.

When it became necessary to readjust the brush on account of wear, the set screw seemed disinclined to let go. On inspection it was found that the part of the screw between the point and the yoke, into which it was tapped, was somewhat larger than when made. The screw was finally gotten out, but the thread in the holder was ruined. It was then tapped $\frac{5}{16}$, and fitted with an ordinary case-hardened, square head, set screw. This is not quite as handsome, from the apparatus makers' standpoint, as the original arrangement, but it is much more satisfactory to the man who runs the motor.

Set screws of brass, especially of the soft yellow brass rod commonly used, are a nuisance, as the points invariably upset as soon as any attempt is made to screw them up tight. There are situations in which iron or steel set screws are inadmissible, but they can be used in nine places out of ten in which those of brass are considered the only orthodox thing. Some makers of fittings are using them quite extensively, and it is certainly a start in the right direction.

The brass yokes which carry the armature bearings are sometimes very weak. This state of things arises, no doubt, from a laudable desire on the part of the maker to economise in the weight of brass, although in many cases it is due simply to bad design, as there is sufficient metal in the yokes to make them amply rigid, if it were properly disposed.

In motors from which the power is taken by a belt, this weakness is not always so perceptible; but when a pinion on the armature shaft is substituted for the belt pulley, the lack of strength may become only too apparent.

There is scarcely any single mechanical detail in a dynamo or motor in which weakness is more fatal than in the armature shaft, and yet this defect is not uncommon. On account of the high speed at which they run, armature shaft bearings are necessarily made very long. On this account, in order that they may not deflect in their own length, the diameter should be considerably greater than that due to the torque alone. A long bearing which springs is worse than a short one which is rigid; and a bearing which is amply large, as far as ultimate strength is concerned, may deflect very appreciably when subjected to the cross pull of the driving belt or the reaction of a small pinion.

In one case, that of a motor, the power of which was transmitted through a small pinion, as in street-car work, the bearing next to the pinion was worn very badly in a very short time, apparently from this cause alone—the weakness of the shaft. The low surface velocity of the journal due to the small diameter is very desirable, but is paid for too dearly when obtained at a sacrifice of strength. Any increase of velocity of sliding due to an enlarged diameter is partially, if not entirely, compensated for by the increase in the bearing area and the reduction of pressure per unit of surface. Switches are frequently constructed in a very unsubstantial manner, with insufficient surface and poor contacts. In a certain reversing switch, the insulating surface on which the sliding block runs, after leaving the last block of the rheostat, is of wood. This wood wears away quite rapidly, and the process is hastened by the temporary arc formed between the blocks on breaking contact, and finally the wood surface has become so much lower than the rheostat blocks as to render the operation of the switch somewhat difficult.

In a switch designed to control a motor attached to machinery in a foundry, the rheostat lever was connected to the hand lever by a light bar pivoted on the points of small headless brass screws. No provision was made for preventing the loosening of these screws except the tightness of their fit in the threads. Owing to a change in the arrangement of the machinery, this switch was not used. How long it would have remained in working order under the conditions necessarily obtaining in a foundry ought not to be difficult to predict.

Sliding contacts can hardly be made too large; it is very easy to make them too small. On this account sliding contacts are preferable to rolling contacts, wherever it is possible to use them. Rolling contacts conveying heavy currents are troublesome things, as everyone who has tried them can testify. This does not apply to the higher voltages and smaller quantities usual in street-car service.

Not all electrical machinery is open to the criticisms made in the preceding Paper, as there is much which is fully up to the standard of the best mechanical work in design and construction.

* From the *American Gas Light Journal.*

Formosa.—According to the British Consul at Tamsui, the new city of Tai-pei Fu, the capital of the Island of Formosa, is lighted by electricity, the apparatus being attended to by native officials.

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The Electrician.

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THE INTERNATIONAL ELECTRICAL CONGRESS OF 1889.

Whether the International Electrical Congress of 1889 is or is not to be pronounced a success depends entirely upon what we may happen to conceive to be the precise scope and functions of an International Electrical Congress. Regarded as a means of bringing together, under conditions of the pleasantest and most interesting kind, a large contingent of workers in the electrical field of various nationality and of varying calibre, nothing could well have been more successful. The roll of the Congress extended to upwards of 600 members, the great majority being naturally of French nationality; yet the English members numbered not less than 40, and the United States was represented by some 12 or 15 well-known names. It would indeed be ungracious—even ungrateful—did we not acknowledge in the fullest sense of the word the unwearied cordiality and marked hospitality of our French *confrères*. From a social point of view the affair was, in fact, a complete success from the first day to the last.

But it must perforce be acknowledged that this is not of itself sufficient to ensure that the Congress of 1889 will live in the history of Electrical Science as an event of real importance. Nor, to be quite candid, do we at all suppose that it will do so. It will be remembered that the ostensible object for which the Congress was held was to continue the work of 1884; but it was sufficiently obvious, as we remarked at the time of the inception of the idea, that the earlier Congress had left but little material for the deliberations of its successor to which any in

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ternational or any pressing degree of importance could be attributed. Some few points of secondary (or even less) importance were, indeed, left outstanding, and upon these the Congress of 1889 has now expended its collective wisdom, and has, we hasten to add, arrived, in our opinion, in each case at a completely satisfactory conclusion. This achievement was, however, somewhat the less arduous since, with but few exceptions, its *rôle* has been limited to the "legalisation" of terms which both the British Association and established usage had already sanctioned. It demanded but little courage or originality to endorse the use of the terms "watt" and "joule;" nor does the definition of such terms as "period," "frequency," "mean" and "effective" current, and "apparent resistance," involve any high order of intellectual effort. With regard to the remaining decisions some few will, however, bear further comment. The Congress has, for instance, officially decided to adopt the long-standing idea of Mr. PREECE, and to substitute the "kilo-watt" for the horse-power as the practical unit of mechanical power. We have not the slightest objection to make; on the contrary, we shall heartily welcome the day when the numeric "746" will disappear from our tables of physical constants. We only wish, however, that we could persuade ourselves that this happy event has been brought appreciably nearer by the vote of the Congress. But when the question is essentially a mechanical one, it is a far reckoning from a casual conference of Electricians to the Institution of Civil Engineers and their compeers. We none the less heartily congratulate Mr. PREECE on having made at least one step towards the goal he has long had in view, and which implies a reform at once scientifically desirable and practically useful.* Turning to the vexed question of photometry, on the proposition of M. VIOLE the one-twentieth part of the (so-called) absolute standard was adopted as the practical photometric unit; this happens to be very nearly one-tenth of a carcel, and hence it is not very different from the English standard candle. The name proposed for the new unit is the "bougie-decimal," but probably we shall hear little of it in this country. We wish the Congress could have seen its way to deal satisfactorily with the far more important question of the absolute standard itself. Possibly, however, the British Association will sooner or later be able to arrive at some conclusion upon this point which another International Congress may give itself the felicity of registering. The Congress has also adopted the recommendations of M. CROVA as to the means to be employed for determining the mean horizontal radiation of an incandescent lamp. The method consists essentially in revolving the lamp while in the photometer. The principle is doubtless sound, although the experiments shown at the meeting were not wholly successful. The "secohm" was thrown over in favour of the "quadrant"—an edict as to which the chief thing to be said would seem to be that it affords Profs. AYRTON and PERRY an excellent opportunity of displaying a loyal submission to the powers that be. The solemn recommendation that metallic circuits should be employed for telephone lines must have been adopted in a weak moment when both the dignity and the limitations of an International Congress were absent from the minds of the members present. We wonder how many Telephone Companies in any known part of the Universe will allow their action in this matter to be influenced by the opinion of the Congress? Suggestions of an even more insipid character were not wanting from the meetings of the Sections, but of these only a single specimen got as far as the General Meeting, where it also received its quietus. (We add parenthetically that we refer to the "pious opinion" of Section III.—that people using telephone call-boxes should not be allowed more than three minutes' talk for a single payment!)

Turning now to the detached papers, considered collectively, we find very little indeed to be said; the majority were decidedly below the average level of the electrical Papers in Section G of the British Association, and like the latter, they consisted for the most part either of *réchauffées* of Papers already read elsewhere or of descriptions of more or less well-known apparatus in too many cases of a more or less unimportant character. We regret to add that even the scanty contributions of the English members found no exception to this rule; Prof. S. P. THOMPSON, Prof. FORBES, and Mr. W. H. PREECE all dealt with questions upon which, however interesting or important, they had already delivered their views elsewhere. Mr. CROMPTON was, perhaps, a partial exception; we do not know that he has ever before promulgated (in public, at any rate) his "Ten Rules for the proper regulation of central station accumulators." But omitting two or three statistical clauses which are not "regulations" at all, the conviction is forced upon one that so sensible, practical, and accomplished an electrician as Mr. CROMPTON could not possibly have fathered any set of rules for the management of accumulators which could appreciably differ from these.

But after all has been said, we repeat once more the sentiment expressed at the beginning, that if we only forbear to demand too high a standard of scientific achievement, the Congress of 1889, with its attendant festivities, was an undoubted, indeed, a marked success, and personally we are sorry that there will not be another till 1892.

PARIS INTERNATIONAL ELECTRICAL CONGRESS.

(FROM OUR SPECIAL CORRESPONDENT.)

Wednesday, August 28.

On Wednesday, Section I. was again occupied with the determination of various units. M. Wuilleumier described the determination of the ohm by an electro-dynamic method due to the President, M. Lippmann. A German silver ribbon had its resistance first determined in C.G.S. units by this method, and then again in legal ohms by comparison with the standards kept in the International Bureau of Weights and Measures. The true ohm was found to be the resistance at 0° C. of a column of mercury one square millimetre in section, and 106·27 centimetres long. The method is a simple modification of that of Lorenz, the solenoid being covered with very fine wire, wound in only one layer, and the E.M.F. used being comparatively large. The approximative accuracy of the result was said to be $\frac{1}{2500}$. Mr. Preece submitted the proposal that he first made, in 1881, to substitute the kilowatt for the horse-power measure of the rate of doing work. The word watt was only proposed in 1882 by Sir William Siemens, but in 1881 Mr. Preece proposed 1,000 volt-amperes as a practical unit. A kilowatt equals 1·358 French *force-de-cheval*, and 1·3405 English horse-power. It is an erg-ten per second. Mr. Preece also proposed to establish a unit intensity of surface illumination, which he would call a "*lux*," the plural being "*luces*." The definition of the lux is the illumination produced by a lamp of one carcel on a surface one metre away from the lamp. It is nearly the same as is produced by the English "candle" at one foot distance. To make the definition exact it would need to be specified whether the light is to be radiated through vacuum or some other standard medium. The Section at this time came to no decision on either of these questions.

Section II. (Industrial Applications) was the favourite rendezvous on Wednesday, and the room was crowded up to after 12 o'clock, the several Papers calling forth much lively discussion.

* A Note read at the Congress by Mr. Preece on the subject of the kilowatt will be found on p. 456.

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The first was by Mr. Crompton, who recommended a set of ten rules for the proper regulation of central-station accumulator installations. These were as follows :—

1. A battery of 54 elements should have sufficient capacity to discharge 100 amperes for 10 hours without the external voltage falling below 100.
2. The same battery should be charged by 200 amperes in five hours.
3. In case of emergency the battery should be able to furnish 500 amperes for half an hour, still maintaining the external voltage at 100—that is, 1·86 volts per element.
4. The normal efficiency should be taken to be that obtained when the battery is charged by a current of 200 amperes and the discharge is 100 amperes.
5. All the connections should be so simple that one man can take charge of six batteries.
6. The battery should be mounted with regulating apparatus, preventing the charging electromotive force from rising more than 5 per cent. above the necessary amount.
7. The connections should be so made that any of the plates or elements may be removed for repair without interruption of the charging or discharging current.
8. The insulation resistance of the battery and its connections should be at least 10,000 ohms even in damp weather.
9. Each element should be covered so to avoid the escape of acid vapours during the charge.
10. The material of the cells should be absolutely resistant to the attack of the acids.

The proposed "rules" did not seem to call forth any remarks, critical or otherwise, and the next speaker was Major-General Webber, who gave particulars of the central station of the Electrical Power Storage Company, at Chelsea,* which supplies 600 amperes at 100 volts, and feed 2,000 lamps of 30 volts. There are eight batteries of 54 accumulators. Five months' trial has shown the consumption of coal to be 5 to 7 kilogrammes per 1,000 watt-hours.

M. Drzewiëcki then expounded a new chemical theory of lead accumulators. He believes that the acid formed during the charge is $H_2Pb_2O_7$. This is decomposed during discharge, H_2O_2 being liberated, which again decomposes into water and free oxygen. The free oxygen combines with the hydrogen of the hydrate of lead, giving water and metallic lead. This theory would make the weight of the plates decrease during discharge, while the ordinary theory would make it increase.

In the discussion which followed, M. Gaston Roux defended the theory of double sulphating, and reminded the meeting that the results of some experiments, which were recently published in *l'Electricien*, showed that the lead plate absorbed 1·41 gramme of sulphuric acid per ampere-hour and the peroxide plate 2·293 gramme, which led one to believe in the existence of two new sulphates of lead. M. E. Reynier thought that the unequal quantity of acid absorbed by the two plates was probably due to a systematic error arising from the employment of a porous vase separating the two electrodes. This suggestion was, however, not entertained by M. Roux, who said that the analysis of the liquid showed an absorption of 3·7 gramme of acid per ampere-hour.

M. Reynier next read a Paper on the "Activity and the Work of Voltaic Couples." The gist of this Paper was a proposal to measure the "activity" by the velocity at which the work done by the cell could lift its own (the couple's) weight. This somewhat fanciful idea was strongly objected to by Messrs. Hospitalier and Faure, and led to a long discussion as to how the power could best be measured. M. Huber contributed a seemingly necessary reminder that the capacities of accumulators are proportional to their exposed surfaces and not to their weights. The President interposed a proposition that it would be desirable to have definite names for the two plates of a cell in an accumulator. Some members wished them to be called "red" and "white," which, whether definite or not, has not a very scientific tone about it. Another member proposed the names "cathanode" and "ancathode." Naturally, no decision was arrived at.

There was then brought forward, on behalf of Mr. Webster, an interesting description of his method of treating sewage and flood waters by letting them flow over cast-iron electrodes connected by copper leads to a dynamo.* All organic matters are precipitated under the action of the current. The method is also applicable to the purification of drinking waters.

Afterwards a dynamometer with fluid resistance was described, but it appeared to possess no particularly interesting features nor any great mechanical merit.

The third Section met in the afternoon only, but had then a most interesting discussion upon the influence of the proximity of lighting and telephonic circuits upon the good working of the latter. This discussion arose out of a Paper by Mr. Lopaz, who attributed the whole effect to leakage from the industrial lines to the earth which forms part of the telephonic circuit. He concluded that all telephonic installations should be constructed with a double-wire circuit, which conclusion was afterwards confirmed by the vote of the meeting. M. Vaschy maintained that the inductive effects due to the proximity of the wires were more important than those mentioned by M. Lopaz, and cited particular installations where the inductive effects had been measured in order to prove his proposition. MM. Palaz, Mercadier, Banneux, Pollard, Barbarat and d'Infreville continued the discussion, taking different views of the matter, and finally it was determined to recommend the universal adoption of the double-wire system, this being important whatever view of the cause of the phenomenon be taken.

In the evening a larger number of the members met at the Central Laboratory at the Place Saint Charles to witness a repetition of Herz's experiments by M. Joubert. These experiments have already been described in this journal, and it is, therefore sufficient to say that the demonstrations were perfectly successful on Wednesday evening. One particular device is, however, worth noting, and is illustrated in the adjoining

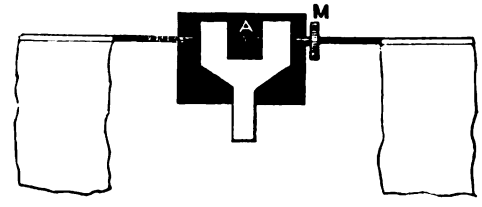

figure. In order to increase the visibility of sparks of the most minute order, Prof. Joubert employs the frame shown in the figure, and which has a piece of black cloth behind the sparking points. This frame is held in the hand, and is brought up close to the eye. The distance between the points is regulated by the screw seen on the right hand; the pieces of tin foil seen on either side may be taken of various sizes in order to act as resonators for the particular rate of oscillation then being employed.

The Units Commission met on Wednesday, and came to two resolutions regarding the joule and the watt, which will be referred to subsequently. This Section (Units and Standards) did not meet on Thursday.

Thursday, August 29.

In the Industrial Section, on Thursday morning, a very interesting Paper was read by M. R. Arnoux on the "Experimental Study of Dynamos." He pointed out that the whole character of a dynamo may be represented by a surface of which the three rectangular co-ordinates are any three of the following four quantities: the mechanical effort, the speed, the current, and the electromotive force. The first three quantities are the only ones that can be determined directly by experiment, because one cannot measure the E.M.F. generated in the armature except by calculation according to Ohm's law from the measured E.M.F. at the brushes. The equation connecting these three being found by experiment, the equation of conservation of energy combined with it gives the fourth quantity. A large number of experimental figures were given to illustrate the method proposed, but it subsequently transpired that these were not the results of original experiments, but were bor-

* See *The Electrician*, August 23, p. 403.

* See *The Electrician*, March 29, p. 588.

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rowed from Silvanus Thompson's book on "Dynamo Electric Machinery."

M. J. Laffargue next read a Paper on the "Relative Economy in the Material of the Leads with Different Systems of Distribution." He showed that the use of three instead of two wires leads to an economy of from 60 to 68 per cent., while, if the current be distributed from two, three, or five centres instead of by means of an ordinary simple circuit, an economy of from 20 to 57 per cent. is obtainable. The economy of leads of varying section was also investigated, but the Paper really contained nothing new.

A Paper by M. Turrettini explained a method of minimising the variation of electromotive force in an electric installation fed by accumulators by help of two dynamos, which together act as a transformer, the one driven by the main current feeding the accumulator-battery, and the second, driven by the first, supplying at higher potential an extra current to the secondary circuit from the battery. This transformer-arrangement is automatically put in action when the E.M.F. of the secondary falls below the permissible limit. This system had been suggested by a similar hydraulic arrangement on the Rhone at Geneva, where a centrifugal pump was automatically thrown into gear when the hydraulic pressure in a certain part of this system fell below a given point. It was said that the cost both of installation and of maintenance would be reduced by the adoption of the device.

In Section III. there was distributed to the members a bulky volume, issued by the Government of the Mexican Republic, describing the progress that that country has made in electrical matters. A cursory examination of this book shows a surprising stage of advancement in Mexico, as may be judged by the fact that there are now about 5,000 miles of telephonic lines in operation. The Section was engaged most of the morning in listening to a Paper by M. Chaze, in which he explained the great advantage that would accrue from the invention of a relay-signal for submarine purposes, such as listening on shipboard in foggy weather for lighthouse signals by help of a combination of the telephone and microphone. It is already possible to make use of this combination if the operator on shipboard keeps his ears continuously to the telephonic receiver, but the utility of the system would be immensely increased by the invention of a signal apparatus which would call the listener to his post whenever there was anything to listen to. By the same system lighthouse guardsmen could obtain intimation of the passage or approach of vessels invisible on account of fog. At the present time, however, no such instrument, to his knowledge, existed. The reader of the Paper was highly complimented by Prof. Hughes, and the sitting terminated with a description of Munier's multiple printing telegraph (details of which we shall probably lay before our readers a little later), and by a discussion regarding the proper number of "tariff" minutes to be allowed for telephonic conversations on public lines.

In the afternoon visits were paid to the electric light installations at the Palais Royal and at the Opera. The machine rooms in both cases are underground, and the temperature was such as to make these visits very fatiguing to the majority of the company. However, a goodly crowd of scientists endured all these hardships in the pursuit of knowledge.

At the Palais Royal there are installed six Edison dynamos which were put down about eighteen months ago, each giving 800 amperes at 110 volts, or 88 kilowatts.

There are also two Zipernowski alternate-current machines of more recent date (having been put down this year), each supposed to give 84 (but actually giving about 80) kilowatts external to the machines. The power is supplied by two four-cylinder compound engines built by Weyher and Richmond. The steam, initially supplied at eight atmospheres pressure during daytime and ten at night, passes successively through all four cylinders; but as there is little or no expansion in the first cylinder, these are called in France triple-expansion engines. Each engine developes about 150 horse-power, the first cylinder being of 10-inch diameter and the second 15 inches. Sets of resistances are conveniently arranged for the regulation of the intensity of the magnetic fields. The whole of the fittings are compactly and well designed, but cannot be described in detail here. This interesting and very successful installation is due to the Compagnie Continentale Edison.

In 1882 the first incandescent lamp installation of the Opera was carried out by the same company. At first 2,500 lamps were mounted, but the number is now over 7,100 16-candle lamps, of which 2,000 are on the stage. The footlights have white and blue globes, the former considerably outnumbering the latter. The lamps are placed as close together as possible across the whole front of the stage. The scenic effects are produced by four rows of lamps in the battens, and each of these can be coloured independently by means of a cylindric revolving shade worked by a windlass and chains from the coulisses at the side.

In the underground workshop there is, firstly, a group of three Edison 88 kilowatt-dynamos (88 amperes × 100 volts), giving continuous-current, and driven by three compound 2-cylinder engines of the vertical inverted type, developing 150 horse-power each, with steam at seven atmospheres. The speed of the engines is 120 revolutions per minute, and that of the dynamos 350. The next group comprises five Edison continuous current machines, each giving, at 820 revolutions per minute, 400 amperes at 105 volts or 42 kilowatts. There are also two alternate-current Gramme machines for feeding Jablochkoff candles. The smaller of these, giving 12 horse-power and feeding 10 lamps, is driven by belt from an Edison motor, whose energy is transmitted electrically from the large Edison dynamos. The second is larger, and is driven direct by belt from the main shaft. It supplies 24 horse-power for 24 Jablochkoff lamps. The whole of this second group, which was put down two and a-half years ago, is driven by a large horizontal two-cylinder Corliss engine, non-compound. The speed is 68 revolutions per minute, and the horse-power 300. The diameter of each cylinder is 19 inches. Besides this there is a four-cylinder compound engine, giving 120 horse-power, and driving four other small Edison dynamos. The boilers in both these installations are of the multitubular Root type, and ample provision for extension has been allowed for, especially at the Palais Royal, where the boiler-power is equal to many times the present rate of steam consumption.

Friday, August 30th.

Friday being the last day of the Section meetings, there was a large attendance in each room, even the Physiological Section sitting for no less than two and three-quarter hours and listening to three Papers. This Section has met altogether three times, but has not been at all well supported.

In Section I., M. Goldhammer gave as the result of his experiments on nickel that the electrical resistance in a magnetic field is proportional to the square of the intensity of the magnetic induction. M. Stoletow described some experiments on electro-actinic discharges; and M. Pilleux gave an interesting communication on the law of thermo-electric couples. The result of his investigation is the following equation:—

$$E = (K - K')(T' - T)$$

where E is the electromotive force generated in consequence of the difference of temperatures T and T′ of the two junctions, and where K is the mean coefficient of variation of electric conductivity of one of the metals and K′ that of the other.

Sir W. Thomson denied that this law was accurate for pure metals.

The other communications in this Section were without much special interest.

In Section II. M. Faure read a long and interesting Paper on the theory of the chemical action in secondary batteries.

M. Faure, after paying a graceful tribute to the memory of M. Planté, indicated what he considered to be a perfect accumulator, namely, one composed of two unattackable plates uniformly covered with active material. The active material, he said, played the *rôle* of conductor, and, according to the makers of batteries, the portion which acts in this capacity was from three to six times greater than that which took part in the chemical reactions. The accumulators of the Planté type had the advantage of possessing a relatively large mass of material which could be electrolysed, but the support

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was liable to be attacked, although the use of antimony overcame this drawback. He thought it quite possible to estimate accurately the capacity of any battery from the weight of its active material so long as the material was in close contact with its support and facilitated the formation of parallel lines of current. In order to properly estimate the value of reduced lead as a positive substance, M. Faure said that we must bear in mind the remark of M. Drzewiecki that there is a great difference of potential between solid and reduced lead. This difference was, he thought, due to the fact that the lead was so finely divided. If we reduce oxide of antimony by electrolysis a powder is obtained, which, when dried, explodes on being struck, liberating much heat. This heat represents the work done in effecting the molecular division. Something analagous, M. Faure said, must take place in the case of reduced lead, the work done being represented in the shape of potential. We have, on one hand, a highly electro-positive body, and on the other a body which furnishes oxygen freely. Sulphuric acid no doubt facilitates the liberation of oxygen, but we must not lose sight of the fact that the sulphating of the peroxide is, from the point of view of the generation of E.M.F., merely a local and deleterious action, In fact, two litharge plates plunged into acid do not give a current, although local sulphating takes place, hence the heat resulting from the oxidation and sulphating of the reduced lead is a measure of the maximum available energy, and all that takes place on the peroxide plate only diminishes this quantity.

Mr G. Roux then read a Paper describing a method of keeping constant the potential of compound-wound dynamos, which from one or other cause have to be run at a speed different from that for which they have been calculated and constructed. The method is a very simple one, and consists merely in taking a shunt between the ends of the series coils and inserting in this shunt a resistance which may be varied according to the speed at which it is desired to run the dynamo. The higher the speed rises above the normal speed for which the winding has been calculated, the lower must this shunt resistance be made, in order to diminish the effect of the series coils. The resistance thus inserted may be regulated either by hand or automatically by the steam-engine governor. The dynamo winding must be made suitable for the *smallest* speed desired. Although this device is by no means new, the Paper provoked a good deal of discussion.

M. Ch. Jacquin then gave in *résumé* a Paper "On Characteristic Curves for Transformers," these curves giving the current, the energy received and that discharged, and therefore also the efficiency, in terms of the resistance and of the current in the secondary circuit.

Prof. G. Forbes then described his well-known meter for measuring both continuous and alternating-currents.

M. Decaux described a series of interesting experiments, comparing the action of sunlight and that of electric light on the water and oil colours used in dyeing and in painting.

M. M. Richard then described several instruments made by his firm, but his descriptions might have been shorter and more comprehensible if he had brought the instruments with him. It seemed rather severe on an audience gathered together for the purpose of discussing electrical matters of general importance, and whose last hours were drawing to a close, to compel them to listen to long, sketchy and rambling references of various instruments whose concrete existence was left entirely to the imagination of the meeting. The result was that an extra afternoon sitting had to be arranged for at two o'clock in order to discuss the definitions of the various quantities coming into the calculation of alternate-current machines and transformers. The results of this discussion, as embodied in the votes of the Section, were as follows :—

1. The name "quadrant" was adopted for the unit co-efficient of induction. This is equal to 10^9 C.-G.-S. units, and is the same as the "secohm" of Messrs. Ayrton and Perry.

2. A special name is not needed for the time-constant L/R.

3. The name "period" is to be applied to the time of a *complete double* (plus and minus) oscillation.

4. The number of periods or of complete oscillations per second is to be called the "frequency."

5. The *mean* current is to be defined in the ordinary way, namely, by $\frac{1}{T}\int_0^T i\,dt$, where i is the variable current and T the complete period.

6. For $\frac{1}{T}\sqrt{\int_0^T i^2\,dt}$ no name could be agreed upon, those suggested being the "virtual," "equivalent," "mean quadratic," "practical," "useful," "effective," "thermal," and "indicated" current.

7. The "apparent" resistance or "resistance fictive" of a circuit is the factor by which $\frac{1}{T}\sqrt{\int_0^T i^2\,dt}$ must be multiplied in order to obtain $\frac{1}{T}\sqrt{\int_0^T E^2\,dt}$ when E is the variable E.M.F. This is more simply stated thus :—

The "apparent" resistance is $\sqrt{\frac{\int_0^T E^2\,dt}{\int_0^T i^2\,dt}}$.

8. In secondary batteries that plate which is connected to the positive-pole of the charging dynamo, and which becomes the positive-pole during the discharge, is to be called the *positive plate.*

In Section III., after some further discussion in continuation of that of the previous day, it was decided that the Congress should recommend that the normal length of the conversation allowed on public inter-urban telephonic lines should be three minutes, and "inter-urban" was defined so as to make it apply to communication between two members or public stations which are parts of different groups.

A proposition of Mr. J. Maier's that the word "phone" should be adopted to mean "telephonic message" was discussed without any resolution being come to, one member proposing the word "telepheme."

Other Papers were read upon "The Influence of Telephony on Telegraphy" (treated from a financial point of view), on "The Multiple Printing Telegraph of M. Baudot," and "On Signalling Time by Telegraphic Wires."

There were two excursions in the afternoon, the first a short visit to the "Instruments of Precision" in the Exhibition, and the second a visit to the electric light installation at the St. Lazare railway station. The latter was well attended. There are here six continuous-current Gramme machines, newly put down and of the most recent construction. In a subsequent issue drawings and detailed dimensions of these machines will be given. They run at 500 revolutions per minute, and give each 450 amperes at 80 volts, or 36 kilowatts. The magnet cores and pole-pieces are of cast iron, and the brushes are divided into eight sections. These are driven by three horizontal steam engines built by Lecouteux and Garnier, running at 180 revolutions per minute with steam at 6½ atmospheres, and each supplying about 150 horse-power. The lamps are all arc lamps of the Cance type.* M. Cance himself guided the party in this visit, and took much trouble in explaining the arrangements, which appear to be in every respect admirable.

Saturday, August 31.

The closing meeting of the Congress took place on Saturday morning at ten o'clock, in the "Salle des Conferences," at the Trocadero. M. Mascart presided, with Sir William Thomson and Mr. Preece at his right and left hands, and supported by the Presidents of all the Sections. He announced that there would be another privileged ascent of the Eiffel Tower on the following morning, and asked for exact copies of all the Papers read in the Sections to be sent to the Secretary before the 15th September, in order that the *Comptes Rendus* of the proceedings might be sent to the members without undue delay. He also asked them to send to the Secretary, at 44, Rue de Rennes, the address to which each member wished his copy of the *Comptes Rendus* to be sent.

* See *Electrician*, September 28, 1888, p. 680.

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Mr. Edison was then elected a Vice-President of the Congress. Mr. Edison has not been able to attend any of the meetings, but he has written to the President to express his wish that his name should be associated with it.

M. Carpentier then read a short Report on "Standard Ohms constructed in consequence of the Decisions of the Congress of 1881." The results of experiments made by MM. Benoit and Carpentier have shown that the mercury standards are absolutely permanent; the differences observed over many years are within the limits of the errors of observation.

The next business was the presentation of the recommendations of the various Sections and Committees that have been appointed by the Sections. The Committee on "Units" recommended that—

1. The practical unit of work should be the Joule = 10^7 C.-G.-S. units, and also equal to the work done in one second by one ampere in one ohm.

2. The practical unit of power should be the Watt = 10^7 C.-G.-S. units, and also equal to one joule per second.

Both these recommendations were confirmed by the unanimous vote of the Congress, the latter being combined with the adoption of the kilowatt as a more useful unit for industrial purposes than the "horse-power." "The bougie-decimal" adopted by Section I. at its Tuesday's meeting was also approved by a unanimous vote, as were also the names "quadrant," = 10^9 centimetres, "period," "frequency," "mean-current," and "apparent resistance" already mentioned in this report as having been settled upon in Section III. on Friday. The "effective current" and "effective electromotive force" were adopted as the names to be employed for the "square root of the mean of the squares" of the current and of the electromotive force.

The recommendation of Section II. to call the "positive plate" of an accumulator that which is connected to the positive pole during charge, and which is itself the positive pole during discharge, was also confirmed by a unanimous vote, as was also the recommendation to use the method proposed by M. Crova and approved by Section II. as the means of determining the degree of incandescence of a lamp. We shall describe this method in detail in a later issue.

The recommendations of Section III., to the effect that the double wire should be used on telephonic urban circuits and inter-urban lines, the term "inter-urban" being defined as has been already explained in this report, was also adopted.

With regard to the fixing of three minutes as the limit of conversations on inter-urban lines, the Congress came to the very sensible determination that this was too much of a pure business matter to be a proper subject for decision by the Congress as a whole, and that it must remain simply as a recommendation of Section III.

The President, before closing the Congress, said that they all felt regret that it was necessary to separate again after a meeting that has appeared much too short. The response to the invitations that the organisers had issued had surpassed their expectations, and the meeting had proved that there existed a general sentiment of scientific concord. He offered, in the name of the Congress, its thanks to the illustrious *savant* who has combined the highest scientific speculations with the study of practical affairs; who has transformed our electrical measuring instruments; has sustained with unconquerable faith the courages of those engaged in the gigantic enterprise of transatlantic cables; while he has also invented transmitters and receivers which, after thirty years of use, have remained almost unmodified; whose compass and sounding apparatus, now everywhere adopted, have been of great benefit to humanity; and who has guided the reforms proposed by the British Association and afterwards adopted by the Congress. The name of Sir William Thomson was on all lips, and he was beloved by all who had the privilege of his intimacy. (This eulogy was received with an extremely remarkable demonstration of enthusiastic assent.) He then referred to the immense extension of electrical activity, and declared that the precision of the language of electricity has led to great advance in the knowledge of natural phenomena. The resolution to apply a special name to each quantity used in practice has contributed in an incalculable degree to the spread of scientific knowledge, this inseparable connection between language and thought being only one particular application of the sovereign law which rules the intellectual development of man. The definitions of the Joule, the Watt, and the Quadrant will be all the more readily accepted because they simply confirm already established usage.

Alternating currents, which have been familiarly known ever since Faraday's first discovery of induction, appeared at first to be insusceptible of useful application. After forty years of experiment, the memorable discoveries of Paccinotti and Gramme gave us the means of cheating Nature, so to speak, so as to obtain all the effects of continuous currents. During recent years, however, alternating currents have suddenly come into favour, and their applications have become numerous. There is hope that this Congress had contributed towards making more precise our ideas, and toward the future avoidance of ambiguities regarding these.

Some members might think that the Congress had not settled enough. Its decisions, however, can only be carried into execution by the help of persuasion, and, therefore, moderate measures agreed to by both those who are impatient for more rapid advance, and those who are more conservative in their ideas, will unite the support of all, and give the resolutions of the Congress more weight and authority.

The great nation of the United States, who have taken so important a part in this Universal Exhibition, have already fixed 1892 as the date of the next *réunion*, and the American Institution of Electrical Engineers invites to that meeting the scientists and the engineers of the Old World. We can only thank them for this invitation, and offer our best wishes for the new bonds that are to be established between the two shores of the Atlantic.

The President of the Republic had charged him to be the interpreter of the great interest he attaches to their labours, and of his regret at not being able to receive personally the whole Congress. He would receive the Bureau of the Congress on Monday, who would express to him in name of all the members their respectful gratitude.

Sir William Thomson, who was received with great cheers, moved a vote of thanks to M. Mascart for the energetic and skilful way in which he had performed the duties of President, and attributed to him the honour of all the success which has attended the meeting of the Congress. The meetings had given him (Sir William) much pleasure, and the results would be useful to the industry. He felt profoundly grateful for the manner in which M. Mascart had referred to him and to his past work, and for the generous appreciation with which the meeting had received M. Mascart's words. The vote of thanks to the President was carried by acclamation, and the Congress was then declared to be closed.

On Monday the Committee of the Congress journeyed to Fontainebleau, where they were received by President Carnot and entertained at luncheon. We may add that out of the long series of Congresses which have been held at Paris during the period of the Exhibition this is the only occasion upon which such an honour has been conferred. The English representatives present were Sir William Thomson and Mr. W. H. Preece.

The following is a list of the English and American members of the Congress :—

John Aylmer, Richard Aylmer, — Barker, Graham Bell, J. D. Bishop, G. B. Burgess, J. De Castro, R. E. B. Crompton, B. M. Drake, L. Drugnah, T. A. Edison, Prof. G. Forbes, Sir Douglas Galton, D. Goldhammer, J. M. Gorham, Ch. G. Gümpel, G. A. Hamilton, E. W. Hammer, C. Hering, Prof. D. E. Hughes, Gisbert Kapp, A. Macfarlane, C. L. Madsen, C. O. Mailloux, Maquaire, W. H. Massey, J. F. Moulton, F. W. Parker, T. Parker, F. J. Parsons, Prof. J. Perry, C. E. Pitman, W. H. Preece, E. W. Rice, Prof. Rowland, John Smith, R. H. Smith, A. Snell, W. H. Snell, Ch. E. Spagnoletti, Aug. Stroh, A. A. C. Swinton, Prof. Silvanus P. Thompson, Sir William Thomson, F. R. Upton, R. W. Wallace, F. H. Webb, Major-General C. E. Webber, A. G. Webster, Joseph Wetzler, H. D. Wilkinson, Joseph Willot.

The following Governments and Societies were also represented :—

The Ministry of Marine, the Société Centrale du Travail Professionnel the Comité Italien, the Japanese Imperial Commission, and the Governments of Belgium, Brazil, Chili, Greece, Hawaii, Italy, Japan, Mexico, and Spain.

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THE KILOWATT.*

BY W. H. PREECE.

In a pamphlet printed in 1881 for the information of the Electrical Congress, then sitting in Paris, I wrote :—

The *erg* is the C.-G.-S. unit of work, but it is so small that it must be multiplied a million times for practical purposes : hence the megerg = 10^6 ergs. Sometimes it is multiplied by 10^{10} and called "ergten." This multiple is more convenient than the megerg, since it approximates very closely to the horse-power of Watt, which is 550 foot-pounds per second. One horse-power is equal to $\cdot746 \times 10^{10}$ ergs. It would be a great benefit to science to replace the horse-power or the *cheval-vapeur*, which are both arbitrary and without basis, by a more scientific unit, and no unit could be more advantageous than the "ergten" (ergdix), which might be called the watt.

Foot-pound	=13·56 megergs	= ·00135	ergten.
Kilogrammetre..	=98·1 ,,	= ·0098	,,
Force de cheval.	=7360 ,,	= ·736	ergten per second.
Horse-power ...	=7460 ,,	= ·746	,, ,, ,,

This proposal was not formally submitted to the Congress, for they had the more important task to determine—the adoption of the C.-G.-S. system of electrical units.

In 1882 William Siemens proposed to call the one-thousandth part of this unit—that is the product of an ampere and a volt, or the volt-ampere—a *watt*, and it was found so convenient to give a short, clear name to a unit which was then in constant and incessant practical use that the watt was eagerly adopted by electricians, and was accepted by the Committee of the British Association in 1888 as the unit of the rate of doing work or of *power*.

It is questionable whether it would not have been better to have adopted my proposition, in which case the volt-ampere would have been the *milliwatt* in preference to the smaller number ; but the volt-ampere or watt having been so universally accepted as a convenient unit, the "erg-ten" becomes the *kilowatt*.

Hence I submit to this Congress that the watt or the power expended by a current of one ampere in a conductor whose ends differ in potential by one volt—that is, 10^7 C.-G.-S. units of work per second—be taken as the unit of power. The result will be that as this is a mechanical and not an electrical unit, when mechanicians comprehend fully the simplicity, the scientific accuracy, and the universality of the system of units adopted by electricians, they will find that the *kilowatt* is a far superior practical unit of power to the meaningless and absurd "horse-power," or to the "force de cheval." The horse-power differs in different countries ; the kilowatt is everywhere the same. The horse-power involves the use and recollection of constants ; the kilowatt contains in its own name the only constant that is wanted. Its use will simplify all calculation of efficiency, for the energy produced and expended in all parts of a complete system are expressed in precisely the same language, and are measured in the same units.

The unit of electrical energy expended for commercial purposes in England is the amount of energy expended by a kilowatt per hour, and hence electric meters measure in kilowatt-hours, and the public employing the current for electric lighting or for the transmission of power pay so much per kilowatt-hour. The kilowatt admits of a very simple abbreviation—"kwt."—and it is especially useful in indicating the capacity of dynamos. If a dynamo is of *x*-kwts., we know at once the engine required to drive it and the amount of electrical energy it will deliver.

Power.

The watt is a mechanical unit, it is 10^7 ergs per second ; hence as one foot-pound per second = 1·356 watts, and a horse-power is 550 foot-pounds per second, therefore a horse-power = 550 × 1·356 = 746 watts. Similarly, a force de cheval, or 75 kilogrammetres per second = 736 watts.

C.-G.-S. unit	1 erg per second.
Watt.....	10^7 ergs per second.
Foot-pound per second	1·356 watts.
Kilogrammetres per second	9·81 watts.
Force de cheval	736 watts.
Horse-power	746 watts.
Kilowatt.....	10^{10} ergs per second. 1,000 watts = 10^3 watts. 1·358 force de cheval. 1·3405 horse-power.

The progress of electrical science has been greatly facilitated by the adoption of the C.-G.-S. system of practical units by the Electrical Congress of 1881, and the fusion of electrical and mechanical science, which is imperative in the further developments and applications of electrical energy, will be greatly benefitted by the adoption of a common and accurate mechanical unit by this Congress of 1889.

* Paper read before the International Electrical Congress.

THE STRIKING OF THE EIFFEL TOWER BY LIGHTNING.*

BY M. MASCART.

Several of my colleagues have thought that it would be interesting to give a few details relating to the striking of the Eiffel Tower on the evening of the 19th August last, an event which has been the subject of several exaggerated accounts. I have taken these details from the report drawn up by M. Foussat, chief of the electrical service, who was on the upper platform during the storm.

The tower is provided with a central rod projecting from the summit, and with eight oblique rods situated on the balustrade of the third platform. The bronze point tipped with platinum, which was orginally at the end of the central rod, had been taken off a few weeks previously on account of its shaky condition.

At 9:40 p.m. the principal lightning conductor at the summit was struck, with a noise like that of two small cannons. Some red drops, due probably to the combustion in the air of volatised iron, fell from the point, and it was subsequently found that the screw at the tip of the conductor was so scored that it was necessary to file it before the set of points could be replaced. A glow, accompanied by considerable crackling, was noticed several times on the rods attached to the platform. The lighthouse-keeper was attending to his apparatus, two men were working the projectors on the platform, and M. Foussat was leaning against the handrail watching the rod attached to the lighthouse. It is worthy of notice that none of these four persons felt the slightest shock at the moment when the flash struck the conductor. However, on account of the heavy rain and the possibility of danger if a second flash struck the tower, the projectors were extinguished, and the three persons on the platform sought shelter in the laboratory. At this moment a highly electrified cloud descended on the top of the tower. It was this doubtless which gave many people in Paris the idea that the top of the tower after the flashes seemed to be enveloped in an electric glow of such intensity that it completely eclipsed the light of the projectors. I should add that the meteorological instruments at the bottom of the conductor experienced no injury whatsoever. This flash was, in short, in conformity with all known facts, and showed moreover that the earth connection was perfect and the tower absolutely safe.

A SUMMARY OF THE DIFFERENCES BETWEEN POSITIVE AND NEGATIVE ELECTRICITY.

In a recent number of *La Lumière Electrique*, M. Decharme sums up in the short article following the principal differences which have been shown to exist in the behaviour of positive and negative electricity :—

It has been shown by Wachter in the *Journal de Physique* that "in a conductor of high resistance the section which is at a mean potential is not symmetrical with respect to its two terminals, and that the higher the resistance of the conductor the nearer to the negative terminal is this point of mean potential." With regard to mechanical effects, it is evident by Lichtemberg's figures, pierced cards, &c., that in discharges of static electricity solid or liquid substances are generally carried towards the – pole and away from the + pole, or, at any rate, more abundantly in this direction than in the other. The action of electrified points on flames may be summed up by saying that negative electricity attracts and positive electricity repels them. An electrified flame is also more powerfully attracted than a flame upon which it induces electricity. It is also well known that there is a decided difference of temperature in the poles of the voltaic arc. In air the + electrode is heated to incandescence, while the – electrode is at a lower temperature. On the other hand if the arc is struck in highly rarefied air, the – electrode attains the temperature of melting platinum, while the + electrode is relatively cool. If one of the electrodes is pointed and the other flat, the point becomes entirely incandescent if it is positive, but it only becomes hot at its extreme tip if it is negative. M. Semmola has devised a very striking experiment to show this phenomenon in an indirect way. He uses a fine point, made of bismuth and antimony, and thus forms a thermo-electric couple. If this point is connected to the conductor of an electric machine, a galvanometer placed in the circuit immediately shows the rise in temperature of the point, and especially so when the point is negative. When a rather long electric spark takes place across an air gap, it sometimes spreads out near the middle, always however closer to the – pole than to the + pole. When the gap is lengthened, the spark frequently assumes an arborescent character, and it is observed that the lateral

* *Comptes Rendus*, Vol. CIX., No. 9.

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branches are all directed towards the – pole, showing clearly that there exists an electric-tension in the body of the spark itself. Moreover, when wires are fused by an electric discharge, the fused metal is projected laterally. The hook-like shape of the electric-spark obtained from the rheostatic machine of M. Gaston Planté shows that the electricity coming from the + pole meets the electricity coming from the – pole at a point close to the latter.

Photographs of sparks exhibit curious differences, characteristic of the two electricities. In 1877, M. A. Righi published a lengthy memoir, entitled, "Ricerche Sperimentali sulla Scariche Elettriche," in which are given numerous illustrations of the electric spark, copied from photographs taken under different conditions by the author. The characteristics of the two discharges are here clearly delineated; the positive discharges being spread out, the negative being more concentrated. The same memoir also contains an illustrated description of the various forms taken by the electric spark in air and in liquids, showing most perfectly the difference in shape and colour presented by the two electricities.

As to the induction spark, it consists of two streams and an aureola. In air, at ordinary pressure, the positive and negative brushes display differences arising from the inequality of potential at the moment of discharge. These differences become less accentuated as the air becomes more rarefied. The hook-like brush shows the same peculiarities as the spark. In a partial vacuum the difference between positive and negative electricity is very marked by the colour of the glow around the two poles, by the shape of this glow, and above all—and this more especially when an induction coil is used—by the presence of striæ. These phenomena are much affected by the medium. In a complete vacuum the purple glow seems to move in the same direction as the positive discharge.

Another fact, not less important, which ought to be kept in mind is that in vacuum tubes and with sufficiently powerful E.M.F.'s, the striæ are always turned in the same direction with the convex side towards the – pole. This phenomenon is analogous to that which is presented where a gas makes its way through a liquid, which it never does in a continuous stream, but always in bubbles more or less large according to the pressure. In the same way electricity, when it penetrates a gaseous medium more or less rarefied, does not pass through it in an unbroken stream, but in a vibratory manner. In this way perhaps the phenomenon of striæ can be explained mechanically, for it is produced with continuous currents as well as with intermittent or alternating currents.

In air at ordinary pressure we can say, so far as regards potential, loss of charge, and propagation, that negative electricity is always at a lower potential than positive electricity, that a negative charge is more rapidly dissipated than a positive, that negative electricity is more easily propagated than positive. The contrary holds good in a disruptive discharge, when positive electricity has the greater tendency to discharge though the air. In rarefied air these differences disappear, whether high potentials or large currents are employed. There is, therefore, nothing absolute about these tendencies, since they depend entirely on the experimental conditions. This, however, does not render these differences more easy of explanation.

In physiological effects the direction of the current is of supreme importance. When a continuous current, acting on a motor nerve, is propagated in the same direction as the nerve ramifications, *i.e*, from the centre outwards, it produces a contraction at the moment of closing the circuit and a sense of pain at the moment of breaking the circuit, and the direction of the current being reversed, a painful sensation on closing and contraction on breaking the circuit. When we operate on a sensory nerve the opposite takes place. Finally, if a current paralyses a muscle, we need only reverse its direction in order to restore its contractile power. We cannot do better than compare the contraction of a muscle at the moment of breaking the circuit to the recoil which takes place in a long water pipe when the flow of water is suddenly arrested by the closing of a tap.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August* 24, 1889.

Following closely upon the meeting of the National Electric Light Association at Niagara Falls came the Convention, last week, of the Edison Illuminating Companies. While the former is a large body which sits with open doors and invites the public into its confidence, the latter is a close organisation whose proceedings are conducted in secret behind barred doors. I would not undertake to say that the bars are actually up and the bolts shot, but it is nevertheless a fact that nobody is allowed to attend unless he has very good right and reason for doing so. The fact is that the Edison Association may be looked upon as a large family wherein all the parties, while they may not have the same ideas, have pretty much the same interests in common, and hence questions are discussed which could not be treated if the deliberations were to be made public. There is, on the part of some Edison men, a feeling that this secret conclave business might be advantageously given up, and that the members might well join the larger body, while all private questions could still be discussed in some private way. Be that as it may, it has been determined to hold the meetings annually hereafter instead of semi-annually. This recent meeting at the Falls is the first of the annuals, and so the Association will not convene again until August of next year. In this respect it might, perhaps, be well if the National Electric Light Association followed the example of the smaller body, for it seems as though the National Electric, being well able to dispose of all its important business at one meeting a year, occupies its ample leisure at the semi-annual meetings by quarrelling and quibbling over constitutional points which are rarely of thrilling interest, but which seem calculated always and everywhere to promote dissension and bitterness. The work of the Edison Association this year appears to have been up to the standard, and as far as can be gathered, some papers presented were of quite general interest. For example, Mr. A. E. Kennelly, the electrician of the Edison Laboratory, brought before the meeting some important results obtained with regard to investigations into the heating of conductors by electric currents. This subject was first suggested to the Edison Standardising Bureau by Captain William Brophy, of the New England Insurance Exchange, and proved to be one upon which very little accurate information was obtainable. Mr. Kennelly therefore adopted the course of taking some 24 wires of different sizes, placing them in pannelling, and passing various currents through them, the highest being 300 amperes, which was considered a maximum for general interior work. Observations were made as to the temperature resulting from these various currents. The highest temperature reached was 100deg. Centigrade, or about 180deg. Fahrenheit, above the surrounding air of the room. This was reached by No. 26 B.W.G. wire with 9 amperes of current. As the wires grew bigger and bigger the temperature lowered correspondingly with the same current, until with the largest wire only 40 degrees Centigrade was reached with 300 amperes. By taking these results, they show what temperature could be reached by any current on a given size of wire under ordinary conditions. As was pointed out, the important question arose as to what might be considered a safe temperature. The Paper which was presented by Mr. Kennelly on the subject embodied valuable data, and will, it is to be hoped, become public property. Another interesting question that was presented was that of the maximum of efficiency of incandescent lamps for central-station work. It will be remembered that some time since Mr. J. W. Howell, in a Paper read before the American Institute of Electrical Engineers, enunciated the law that the point of maximum efficiency is reached when the lamp bills are about 15 per cent. of the total expenses of the station. This law was analysed in a Paper by Mr. Carroll, who pointed to certain conditions which he considered should modify the operation of such a law, and would thus render it an equitable basis for the calculation of conditions to govern in central-station practice. Mr. Howell will be invited to reconsider the subject, and, if possible, formulate a modification of his Paper in the shape of practical rules for the use of managers of Edison central stations, so that they may be enabled to judge just when the various factors that have to be taken into account are at the right point. A very interesting subject brought up was that of the use of high potentials as an adjunct to Edison central station work. Mr. Gilbert, of Detroit, offered a resolution stating that the Edison local companies had suffered in their business for the lack of an efficient and inexpensive arc-lighting system, an arc lamp which could be put on an incandescent three-wire system, and a flexible method of covering the territory so that the remote districts could be covered in some other way than by the three-wire system. Mr. Jenks, of the parent company, presented an able Paper or report touching on the points raised in this resolution, and discussing the various ways in which the Edison stations might be better enabled to meet the sharp competition which

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they are naturally subjected to. As was pointed out, if the Edison manager let the arc-light business alone, somebody was sure to come along and supply that want; but it did not take many months before the arc-light station found that it was necessary and desirable to go into the incandescent lighting business, and hence competition arose which might be avoided, or if not avoided, might be successfully met. Mr. Jenks made the interesting statement that Edison direct-current transformers would now be supplied to stations desiring to go into long-distance work. There are two varieties of these machines in prospect. In the one now operated they have a motor and dynamo combined in one, the armature being provided with two independent sets of coils, a commutator at each end, and no pulley. The high-pressure current of a thousand to twelve hundred volts from a municipal dynamo is received on one commutator, and the low-pressure current of one hundred to one hundred and twenty-five volts is sent out from the other. The machine is regulated from the primary generator. Five sizes are proposed, ranging from 60 to 640 amperes. Mr. Jenks also stated, and he was corroborated by Mr. Herrick, the new vice-president of the Edison General Electric Company, that the company will soon be prepared, in cases where a comprehensive series-arc system is desired, either to furnish, or definitely recommend and endorse, some efficient economical system, and, if desirable, superintend its installation. There can be no doubt about it, that many Edison stations will soon be found doing a long-distance electrical business for lighting and power. With regard to the motor business, it was stated that the three New York central stations are now delivering every day upwards of 500 horse-power current to motors, and that in Boston about 700 horse-power is being delivered, an addition of 150 horse-power since June 1st. Among other interesting subjects brought up before the Convention were the question of grounding the neutral conductor in 3-wire systems, the location of grounds in underground tube systems, the improvements in the Edison chemical meter, and the ingenious new method of running interior wires through non-conducting and non-inflammable tubes placed throughout a building so that the conductors can be installed after the building has been completed. The Association also took up the question of mutual insurance, and a committee recommended that as many central station officials as possible, in order to secure lower rates than are granted by the regular stock companies, agree in writing to transfer certain portions of their insurance to mutual companies at one per cent.

Some few years ago, one of the doughtiest of the opponents of electric lighting was General Hickenlooper, a leading representative of gas interests in Cincinnati. He sifted the entire technical press of the world for reports of trouble with electric light plants, published columns of "accidents" in the daily papers, and even issued pamphlets on the subject. But the gallant general has now shown himself to be something more than a Mrs. Partington trying to sweep back the Atlantic with a broom. He has recognised the fact that the electric light has come to stay, and he now proposes to make it a welcome guest. His recantation takes the shape of a splendid new electric light station for Cincinnati, and so well satisfied is he with the prospects that he has had the plans made to include a duplicate station to be built as soon as possible after the first has started. This change of front is not singular or unique, however, for every week record is made in the journals of some gas company or other that has bought electric lighting apparatus, or that seeks power to go into the business.

We need not wonder that the business is attractive when we are told that in one plant started for arc-lighting some few years ago in a city of about 100,000 inhabitants on a capital of $80,000, the net yearly profits each year have equalled the original cost of the plant, and that a "cash down" offer of $260,000 has been made for the plant as a going concern. In other words, the plant to-day represents a return of $580,000 for the original investment of $80,000. This is on arc-lighting. The prices are not as good for arc lights as they once were, but they are still living prices, while the motor industry has grown up as an additional source of income. One superintendent of a station supplying about 125 horse-power of current for motors stated recently that his profit figures out about 38 per cent. on the original investment.

A special committee that has been investigating the subway explosions now so frequent in this city, reports that the trouble all lies with the gas companies, whose mains are leaky. It is recommended that the subways be steadily and regularly kept free from gas by means of blowers, such as are already in use; and further, that some competent Board be organised that shall have jurisdiction over all underground work of whatever character, so that the various services and interests shall not clash, and that the streets shall be saved from utter wreck. Even if a Board be appointed, I shall not be surprised to see New Yorkers starting a Street Preservation Society. It is badly needed.

CORRESPONDENCE.

THE ELECTROMAGNETIC EFFECTS OF A MOVING CHARGE—III.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In two previous communications under the above title (*The Electrician*, November 23, 1888, p. 83, and December 7, 1888, p. 147) I have discussed this matter. Referring to the case of steady rectilinear motion, I gave a description of the result when the speed of the charge exceeds that of light, obtained mainly by general reasoning, and stated my inability to find a solution to represent it. The displacement cannot be outside a certain cone of semi-vertical angle whose sine equals the ratio v/u of the speed of light to that of the charge, which is at the apex.

In the *Phil. Mag.* for July, 1889, Prof. J. J. Thomson has examined this question. Like myself, he fails to find a solution within the cone; but concludes that the displacement is confined to its surface. If so, it must form, along with the magnetic induction, an electromagnetic wave. But it may be readily seen that such a wave is impossible, having no stability.

For as the charge moves from A to B, a given surface element, C, would move to D. In doing so its area would vary directly as its distance from the apex, and the energy in the element would therefore vary inversely as its distance from the apex, and the forces, electric and magnetic, would therefore vary inversely as the square root of the distance from the apex, instead of inversely as the distance, which is obviously necessary in order that the displacement may be confined to the surface. This conflict of conditions constitutes instability. In the *Phil. Mag.* for April I suggested that whilst there must be a solution of some kind, one representing a *steady* state was impossible. This conclusion is confirmed by the failure of Prof. Thomson's proposed surface wave to keep itself going.

Prof. Thomson, who otherwise confirms my results, has also extended the matter by supposing that the medium itself is set in motion, as well as the electrification. This is somewhat beyond me. I do not yet know certainly that the ether can move, or its laws of motion if it can. Fresnel thought the earth could move through the ether without disturbing it; Stokes, that it carried the ether along with it, by giving irrotational motion to it. Perhaps the truth is between the two. Then there is the possibility of holes in the ether, as suggested by a German philosopher. When we get into one of these holes, we go out of existence. It is a splendid idea, but experimental evidence is much wanting.

But if we consider that the medium supporting the electric and magnetic fluxes is really set moving when a body moves, and assume a particular kind of motion, it is certainly an in-

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teresting scientific question to ask what influence the motion exerts on the electro-magnetic phenomena. I do not, however, think that any new principles are involved.

The general connections of **E** and **H**, referred to fixed space without conductivity being

$$\text{curl}\,(\mathbf{e}-\mathbf{E})=\mu p\mathbf{H}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\text{curl}\,(\mathbf{H}-\mathbf{h})=cp\mathbf{E}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where p stands for d/dt and **e** and **h** are the impressed parts of **E** and **H**; if there is also motion of electrification, we have to consider it to constitute a convection-current, a part of the true current, and so make (2) become

$$\text{curl}\,(\mathbf{H}-\mathbf{h})=cp\mathbf{E}+4\pi\rho\mathbf{u} \quad . \quad . \quad . \quad . \quad (3)$$

where ρ is the density of electrification, whose velocity is **u**. (See *The Electrician*, November 23, 1888, p. 83). It now remains to specify **e** and **h**. They are zero when the medium supporting the fluxes is at rest. But if it moves, and its velocity is **w**, there is, first, the electric force due to motion in a magnetic field,

$$\mathbf{e}=\mu\mathrm{V}\mathbf{w}\mathbf{H} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

which is well known; and next the magnetic force due to motion in an electric field,

$$\mathbf{h}=c\mathrm{V}\mathbf{E}\mathbf{w} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which is not so well known. [First, I believe, given by me in the third section of "Electromagnetic Induction and its Propagation," *The Electrician*, January 24, 1885; again, obtained in a different way in section XXII., January 15, 1886; *see* also *Phil Mag.*, August, 1886, and an example of the use of (4) and (5) in *The Electrician*, April 12, 1889, p. 683.]

The mechanical force called by Maxwell the "electro-magnetic force" is $\mathrm{V}\mathbf{C}\mathbf{B}$, where **C** is the true current and **B** the induction. It is the force on the matter supporting electric current. Let it move. If **w** is its velocity the activity of the field is

$$\mathbf{w}\mathrm{V}\mathbf{C}\mathbf{B}=\mathbf{C}\mathrm{V}\mathbf{B}\mathbf{w}=-\mathbf{e}\mathbf{C} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Similarly, as I obtained in Section XXII. above referred to, there is a mechanical force (the magneto-electric) on matter supporting magnetic current $\mathfrak{G}=\mu p\mathbf{H}/4\pi$, expressed by $4\pi\mathrm{V}\mathbf{D}\mathfrak{G}$, and its activity is

$$4\pi\mathbf{w}\mathrm{V}\mathbf{D}\mathfrak{G}=4\pi\mathfrak{G}\mathrm{V}\mathbf{w}\mathbf{D}=-\mathbf{h}\mathfrak{G} \quad . \quad . \quad . \quad (7)$$

Of course **e** and **h** are impressed forces, which is the reason of the change of sign. *Their* activities are $\mathbf{e}\mathbf{C}$ and $\mathbf{h}\mathfrak{G}$.

It should be remarked further, that the above expressions for **e** and **h** are not *certain*. For I have shown that the sources of all disturbances are the lines of curl of the impressed forces (*Phil. Mag.*, Dec., 1887), and that the fluxes produced depend solely upon the curls of **e** and **h**, both as regards the steady fluxes and the variable ones leading to them. We may, therefore, use any other expressions for **e** and **h** which have the same curls as the above. And, in fact, we see that equations (1) and (2) only contain their curls.

Equations (1) and (3), with **e** and **h** defined by (4) and (5) therefore enable us to determine the effect of the moving medium. Prof. Thomson also arrives at (4) and (5), and at the "magneto-electric force," in his Paper to which I have referred, by an entirely different method. And to show how well things fit together, he concludes, from the consideration of the moving medium, that a moving electrified surface is a current sheet, which is another way of saying that a convection current is a part of the true current, as expressed in (3). I must however disagree with Prof. Thomson's assumption that the motion must be irrotational. It would appear, by the above, that this limitation is unnecessary.

As an example, and to introduce a new point, take the case of a charge q moving at speed u along the axis of z. It will come to the same thing if we keep the charge at rest, and move the medium the other way. We then use the equations (1) and (2), and in them use (4) and (5) with $\mathbf{w}=-\mathbf{u}$. Now when the steady state is arrived at, we have $p=0$, so (1) and (2) become

$$\text{curl}\,(\mu\mathrm{V}\mathbf{H}\mathbf{u}-\mathbf{E})=0, \quad . \quad . \quad . \quad . \quad (8)$$

$$\text{curl}\,(\mathbf{H}-c\mathrm{V}\mathbf{u}\mathbf{E})=0, \quad . \quad . \quad . \quad . \quad (9)$$

In addition, the divergence of **D** must be q at the origin, and the divergence of **B** must be zero. The latter gives, applied to (9)

$$\mathbf{H}=c\mathrm{V}\mathbf{u}\mathbf{E}, \quad . \quad . \quad . \quad . \quad . \quad (10)$$

which gives **H** fully in terms of **E**. Eliminate **H** from (8) by means of (10) and we get

$$\text{curl}\,(\mu c\mathrm{V}\mathbf{u}\mathrm{V}\mathbf{E}\mathbf{u}-\mathbf{E})=0, \quad . \quad . \quad . \quad (11)$$

or

$$\text{curl}\left[\frac{u^2}{v^2}(\mathbf{E}-\mathrm{E}_3\mathbf{k})-\mathbf{E}\right]=0 \quad . \quad . \quad . \quad (12)$$

where E_3 is the z component of **E** and **k** a unit vector along z; or, integrating, and writing the three components,

$$\mathrm{E}_1=-\frac{d\mathrm{P}}{dx}, \quad \mathrm{E}_2=-\frac{d\mathrm{P}}{dy}, \quad \mathrm{E}_3=-\left(1-\frac{u^2}{v^2}\right)\frac{d\mathrm{P}}{dz}, \quad (13)$$

where P is a scalar potential; here is the new point. There *is* a potential, of a peculiar kind. The displacement due to the moving charge is distributed in precisely the same way as if it were at rest in an eolotropic medium, whose permittivity is c in all directions transverse to the line of motion, but is smaller, viz., $c(1-u^2/v^2)$, along that line and parallel to it. The potential P is given by

$$\mathrm{P}=\frac{q}{c\left[(x^2+y^2)(1-u^2/v^2)+z^2\right]^{\frac{1}{2}}} \quad . \quad . \quad . \quad (14)$$

It is a particular case of eolotropy with c_1, c_2, c_3, the principal permittivities, all unequal. Thus, with q at the origin, the potential is

$$\mathrm{P}=\frac{q}{(c_1c_2c_3)^{\frac{1}{2}}\left(\frac{x^2}{c_1}+\frac{y^2}{c_2}+\frac{z^2}{c_3}\right)^{\frac{1}{2}}} \quad . \quad . \quad . \quad (15)$$

Observe that although the electric force in the substituted problem of a charge at rest in an eolotropic medium is the slope of a potential; yet it is not so when the medium is isotropic, and moves past the fixed charge, or *vice versâ*, although the distributions of displacement are the same.

When $u=v$ we abolish the permittivity along the z-axis in the substituted case, so that the displacement must be wholly transverse. We then have the plane electromagnetic wave. When u is greater than v it makes the permittivity negative along z; this is an impossible electrical problem, and furnishes another reason for supposing that there can be no steady state in the corresponding electromagnetic problem.

It now remains to find what *would* happen if electrification were conveyed through a medium faster than the natural speed of propagation of disturbances. There is the cone; but what takes place within it?—Yours, &c., OLIVER HEAVISIDE.

Aug. 25, 1889.

THE THEORY OF ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The writers of the interesting letters which have lately appeared in your columns raise many points on which I should like to comment, but at present I have not time to deal with the matter in any detail. I may say, however, that in my opinion the points which may have been overlooked or misunderstood by some of your correspondents have been very clearly indicated in your editorial remarks.

It appears to have been thought that because I did not give many details of actual tests the views expressed in my Paper were founded on very incomplete information. As a matter of fact, the Paper was so long that I had not space to record the particulars of the tests, and had to content myself by stating the general conclusions to which the experiments pointed.—Yours, &c., W. M. MORDEY.

London, Sept. 3, 1889.

"AN IMPROVED LIGHTNING PROTECTOR."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Absence has until now prevented me from seeing the letters on this subject in your issue of August 23rd. In the article suggesting the adoption of a fine wire coil in intimate

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association with an earthed cylinder, I was particularly careful to say that such an arrangement was novel, *so far as I was aware*, because it seemed improbable, in spite of the fact that I did not remember to have seen it proposed, that such an obvious and simple device could have been overlooked by electricians devoting special attention (which until recently I had not done) to lightning protection. I am consequently neither surprised nor annoyed to learn that the idea had occurred to Mr. Jamieson, whose discharger, as described in Messrs. Clark, Muirhead, and Co.'s letter, appears to me to possess very considerable merit. It embodies the feature which direct observation over a considerable period on instruments that accidentally contained it has shown to act with remarkable regularity in discharging lightning. My suggestion was the direct outcome of this experience. With regard to Mr. Noble, I can only regret that the results of our experience do not agree better. My statement (to which I completely adhere) about translator coils was made partly on the evidence of my own senses and partly on reports from officials having to do with them, including one from a mechanic who has the duty of re-winding fused instruments. The assertion that the suggested protector is identical with the discarded bobbin protector of the Post-office may be true, for I do not know what that protector was like; but judging from the inaccurate character of several of Mr. Noble's concluding remarks, I think it more likely to be not. For instance, the necessity of protecting serrated dischargers from dust is wholly imaginary. The efficiency of the plate discharger is *not* greater than that of a good serrated one, while in damp situations the plate is more liable to cause leakage. Post-office cables are not invariably protected in the elaborate manner set forth.—I am, &c.,

A. R. BENNETT.

Duddingston Park, Portobello, N.B.,
Sept. 3, 1889.

BOOKS, &c., RECEIVED.

"The Mathematical Theory of Electricity and Magnetism." By H. W. Watson and S. H. Burbury. Vol. II. (Oxford: Clarendon Press.)

"La Electricidad en la Exposicion Universal de Barcelona." By D. Antonino Suárez Saavedra. (Barcelona.)

"Calendar for the Session 1889-90." University College, Bristol.

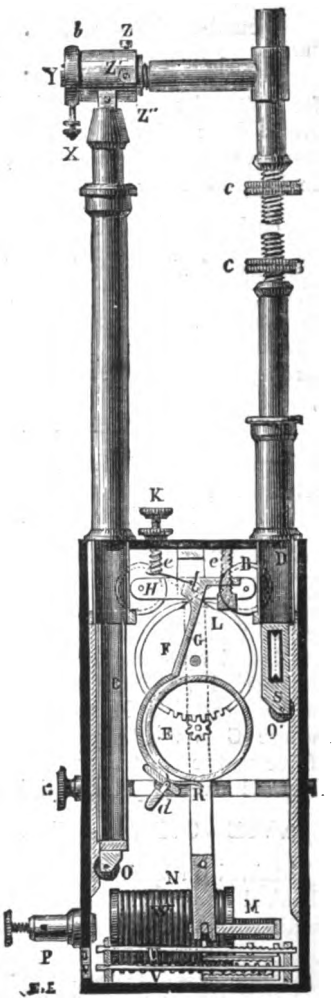
"Machine Driving by Electricity." The United Electrical Engineering Company, Westminster.

"The Republic of Uruguay, 1888-89."

"University College, Liverpool. Prospectus of Day Classes in Arts and Sciences, and of the Evening Lectures. Session 1889-90." (Liverpool: F. and E. Gibbons.)

THE HAUCK ARC LAMP.*

The Hauck lamp is self-focussing. The two carbon-holders, C and D are connected by an endless cord, which starts from O, passes over the pulley H, round the wheel L, and over the pulleys



B and S to O', whence it is finally taken to the upper plate of the framework. Whenever the wheel L is free, the weight of the positive rod is sufficient to cause it to slide downwards and pull up the negative rod. But when the wheel L is braked the friction of the endless cord is so great that the whole mechanism is kept

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the author.

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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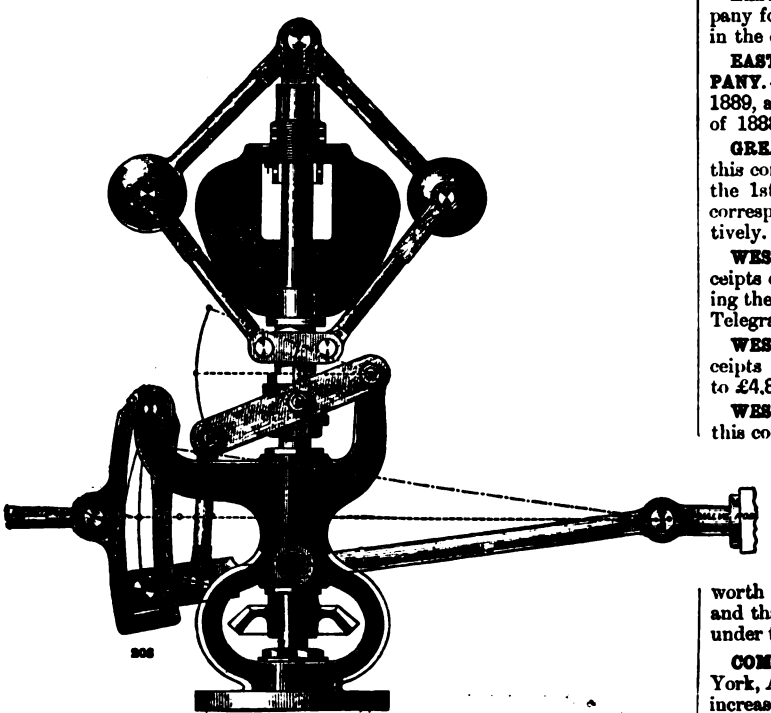
motionless. The pulleys H and B are placed at the end of a T-shaped piece, G, which oscillates round the point *j*, and terminates in a sort of stirrup attached to M, the armature of the solenoid W. The armature M is kept in position by the horizontal spring V, the tension of which can be accurately regulated. The solenoid W is wound with thick wire, and is traversed by the entire current. A brake wheel, E, is mounted on the arm G, and on the axis of E there is a small pinion, engaging with the wheel F, which is furnished with teeth along a certain portion of its circumference. The upper end of the brake rod is bent flat; it is secured by the screw *e*, and kept in a regulated position by means of a spring adjustable at K.

When the current passes through the lamp the armature M is attracted by the solenoid, and G moves round, raising the pulley H, lowering the pulley B, and braking the wheel E. When the current weakens the spring V pulls back the armature M, and the wheel E is freed. The positive carbon-holder descends and the negative carbon-holder is pulled up, the result of these two movements being to diminish the length of the arc.

By means of the screw *a* acting on *d* the wheel E can be braked whenever required. The length of arc is limited by the screw V. The strip R is arranged so as to check the movement of E whenever it becomes too rapid. The upper carbon-holder can be adjusted by means of a series of screws, L, L′, L″, X, Y and *b*, until the carbons are exactly in line.

A NEW GOVERNOR FOR ELECTRIC LIGHT ENGINES.

The illustration given herewith shows a new form of governor recently introduced by Messrs. Clayton and Shuttleworth, the well-known engineers, of Lincoln, which will commend itself for its simplicity, fewness of wearing parts, and efficiency. As the speed of the engine tends to increase, the governor balls and central weight rise, lifting the die in the link and cutting off the steam earlier by thus automatically reducing the travel of the cut-off valve.



The movements of the new governor are regulated as follows: On the vertical spindle is screwed a small piston, accurately fitting a brass-lined cylindrical recess in the central weight, the result being that as this weight rises, the air occupying the space between the bottom of the cylinder and the piston is compressed, thus giving the resistance required to prevent oscillation without the aid of unsightly springs and dashpots. The governor is so proportioned as to be nearly isochronous, and repeated experiments have proved that engines fitted with this expansion gear run at practically the same speed under the most extreme variations of load.

For electric lighting purposes in particular this governor will be found to be well worthy of the careful attention of our readers.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended August 30, 1889, amounted to £4,877.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of August, 1889, were £2,700, as compared with £2,860 in the corresponding month of last year. The receipts for the month of May, estimated at £3,500, realised £3,513.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of August, 1889, amounted to £1,624, as compared with £1,643 last year.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of August, 1889, amounted to £52,012, and to £43,703 in the corresponding period of 1888.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of August, 1889, amounted to £39,469, and to £38,103 in the corresponding period of 1888.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company for the month of August, 1889, amounted to £24,000. From the 1st January to 31st August, 1889, they were £178,200, against, in the corresponding months of 1888 and 1887, £179,200 and £174,120 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended August 30, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,622.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended 31st August, 1889, amounted to £4,850.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this company for the half-month ending August 31 amounted to £2,118, as compared with £2,520 in the corresponding period last year. The May receipts, estimated at £6,219, realised £6,203.

BANKRUPTCY.—In Friday's *Gazette* the bankruptcy was announced of E. Liversedge, electrical engineer, of Huddersfield.

CHANGE OF NAME.—We are informed by Messrs. Charlesworth and Co. that they have made a change in the name of their firm and that henceforth they will carry on the business of electrical engineers under the style of "Charlesworth, Hall and Co."

COMMERCIAL CABLE COMPANY.—A Reuter's telegram, dated New York, August 31, announces that this company has filed a notice of the increase of its capital from 6,000,000 to 10,000,000 dollars.

NATIONAL TELEPHONE COMPANY (LIMITED).—Application has been made to the Committee of the Stock Exchange for a quotation for shares in this company (Nos. 1 to 386,375), in lieu of those of the United Company.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

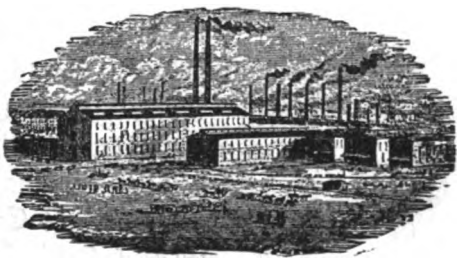
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 56ft. 6in. by 28ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Sept. 4, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 4, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	15/0	Anglo-American	52 53	4 14 4	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	30/0	Do. Preferred	88½ 89½	4 7 7	,, ,,	89½	88½
2,614,820	Stock	...	Do. Deferred	17½ 18	...	February	18	...
130,000	£10	5/0	Brazilian Submarine	13 13½	5 18 6	Mar., June, Oct., Dec.	13½	13¼
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	15	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 6	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	9	...
60,710	20	3/6	Direct United States	10⅛ 10⅜	5 16 2	Jan., Apr., July, Oct.	10⅛	10⅛
380,000	10	5/6	Eastern	13⅜ 13⅝	4 15 5	,, ,,	13⅝	13⅜
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15½	3 16 2	,, ,,	15⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109⅛	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	107⅜	...
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13 9/16	13 7/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	4/0	Globe Telegraph and Trust	8⅜ 8⅝	8 7 3	Jan., Apr., July, Oct.	8⅝	8⅜
178,992	10	3/0	Do. 6 per Cent. Preference	14⅞ 15⅛	3 19 4	,, ,,	15	14⅞
150,000	10	5/0	Great Northern	15¼ 15⅜	4 15 3	Jan., July, and April	15⅜	15 1/16
17,000	25	37/6	Indo-European	40 42	6 1 6	April and October	...	...
9,000	8	8/0	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	9¾	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
30,000	10	5/0	West Coast of America	10 10½	5 14 3	January and July	10⅜	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	2 1/16	...
34,563	10	12/0	Do. 1st Preference 6%	12 12⅜	...	April and October	12 1/16	...
4,669	10	*	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	9/0	Western Brazilian	10⅜ 11¼	6 10 4	March & September	11	...
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ 5/16	4 8 3	...	...	...
55,000	5	...	United River Plate	5¼ 5½	...	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 3⅝	...	...	3½	3⅜
23,692	5	2/0	Do. (fully paid)	4⅛ 4⅜	...	February & August	4⅜	...
79,934	5	...	Swan United (£3. 10s. paid)	4¼ 4⅜	...	...	4⅜	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 4	March and July	45½	45
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	...	...

* No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
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3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 591.—Vol. XXIII. FRIDAY, SEPTEMBER 13, 1889. Price Fourpence.

NOTES.

The fifty-ninth annual meeting of the British Association was opened at Newcastle-on-Tyne on Wednesday evening. Sir Frederick Bramwell, F.R.S., the retiring President, introduced his successor, Prof. Flower, F.R.S., who delivered an address on "The Practical Organisation of Natural History Museums." Over 3,000 persons were present, and an enthusiastic reception was given to the new President. So far it would appear that the general attendance is likely to exceed that of last year; the number of physicists present is, however, about the same—that is, rather below the average. The Local Committee has spared no trouble to ensure the comfort and convenience of the visitors, and has succeeded in housing the whole of the Sections within a comparatively small area. Section A is excellently bestowed at the College of Science, whilst Section G makes shift with a Presbyterian Church.

Yesterday (Thursday) morning was, as usual, devoted to the Presidential addresses in the Sections, and, as we have previously intimated, the proceedings do not possess any direct interest for our readers. None of the Papers read in the afternoon in Sections A and G related to electricity.

The exceeding crudity of our existing appliances for the manufacture of light is an unfortunate fact with which Dr. Oliver Lodge has by this time made us all fairly familiar. (Or, if there be any who are not yet prepared to subscribe to this, they may be referred to the Lecture on "The Modern Theory of Light," which appeared in our last number). In the absence—so far at least as is generally known—of any very promising line of experimental research on behalf of a method of obtaining luminous vibration unaccompanied by its lower octaves, it is satisfactory to learn that no less a personage than Prof. E. Wiedemann is engaged upon a theoretical investigation of the general subject, with a view also of determining experimentally the numerical values of the quantities involved. Prof. Wiedemann had indeed written something on this question as long ago as 1878, and he has since then referred to it more than once. The current number of the *Phil. Mag.* contains, however, the first instalment of a Paper which is surely destined to become a classic, and to which we must refer those of our readers who wish to follow up the subject. All we can say here is that Prof. Wiedemann gives the name "luminescence" to the phenomena of a body radiating light waves at a temperature which corresponds only to greater wave lengths, and he shows that the phenomena is more frequent than is usually supposed. Luminescence includes all such cases as phosphorescence, fluorescence, vacuum-tube discharges, as well as cases of chemical action, including many instances of flame.

Prof. Wiedemann's theory may perhaps be crudely indicated in a few words. In the case of a gas at a given temperature and pressure, its total energy, according to the usual hypothesis, is distributed according to a fixed and perfectly definite ratio betwixt the internal vibrations of its molecules and their motions of translation. If this were not so, there could be no condition of equilibrium. If, however, the molecules be subject to certain kinds of periodic disturbance, the equilibrium between the two kinds of molecular motion may be upset. The balance tends to restore itself as soon as the exciting cause is withdrawn; but meanwhile, if the internal movements have been augmented at the expense of the external, we should have the phenomenon of luminescence. Similar views, with due restrictions, are applied to solids, and it is shown that if the restoration of balance does not appreciably commence until the excitation is withdrawn, we get what we call phosphorescence; if it proceeds concurrently we have fluorescence. It would certainly appear that in the hands of Prof. Wiedemann this theory is at the very least destined to throw further light upon the nature of Geissler-tube phenomena.

In connection with the contract for the central lighting station at Les Halles, which is still under negotiation by the Paris Municipal Council, some official tests were recently carried out by Messrs. Potier and Carpentier on a new alternator, designed and constructed by MM. Dandeu and Naze. Their report was very unfavourable, the machine, constructed for an output of 220,000 watts, being alleged to heat unduly with a load of only 60,000 watts. On receiving this report an order for Ferranti plant was immediately confirmed. This issue has called forth a most vehement and rhetorical protest from MM. Dandeu and Naze, in which they impeach the *bona fides* of the experiments carried out by MM. Potier and Carpentier, and denounce the Council for lending itself to the introduction of English plant. The Council had already resolved that all the material must be manufactured in France, and the Ferranti machines are supposed to have been built at Cail, but this is stoutly denied by MM. Dandeu and Naze. These gentlemen have also a good deal to say about transformer patents, and the inhuman persecution of the late M. Gaulard. Their position will be

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better understood if we mention that the central lighting station at Tours, erected in 1885, was carried out by them in conjunction with Messrs. GAULARD and GIBBS. It was a series-system hand regulated, but we believe it has since been changed to parallel.

A CORRESPONDENT writes as follows:—"I met in Paris a few days since an American who had thrown himself into a state of considerable excitement over 'EDISON'S latest invention'—'A Telephone, Sir, which transmits at the rate of 7,428 words per minute.' Certainly the statement did appear with all due gravity in the copy of *Le Temps* which he handed me, but when I had remarked that it would probably require about eight men and a boy to listen at the aforesaid rate, my friend seemed dimly to perceive that there must be something wrong somewhere."

THIS amusing mistake arose, as may easily be supposed, from the substitution of the word telephone for telegraph. But, even so, many of our readers will be surprised to learn that any telegraph apparatus exists capable of working at the rate of over 7,000 words per minute. At the Edison stand in the Paris Exhibition there is, however, an instrument bearing an inscription to the effect that on a date mentioned 7,428 words were transmitted by its agency, over five wires, between New York and Philadelphia. Even when allowance is made for the number of wires employed, we take it that this is the most remarkable feat of rapid telegraphy ever yet accomplished. If we are mistaken in this we should be glad to be corrected.

WE much regret to note that the divergence of opinion which has lately developed itself in the ranks of the NATIONAL (U.S.) ELECTRIC LIGHT ASSOCIATION has culminated in a quarrel whose virulence seems almost to threaten the continued existence of the Association, and has, at any rate, utterly demolished for the time being the dignity and credit of a large number of its members. Amidst the hurricane of denunciation it is a little difficult for an Englishman to make out precisely what the uproar is about. Such terms as "discreditable," "unscrupulous," "unprincipled trickster," "wrecker," "pirate," &c., &c., seem to have been liberally employed, especially in the editorial columns of one at least of their representative journals. Probably, however, compliments of this kind are taken less to heart and inflict less injury, whether upon the originator or the recipient, than would be the case with ourselves; if so, it would be, of course, a mistake to attach too much importance to the episode. So far as we can make out, the trouble had its origin in the introduction, some time since, of a class of Associate Members, who were not necessarily electric lighting men, but were usually connected with the trade in fittings. The presence of these individuals has from the first been a source of offence to a certain section, and they appear to have succeeded in carrying an amendment to the constitution which would ultimately have had the effect of altogether excluding this class from the Association. Naturally this was not accomplished without giving rise to much ill-feeling; the storm did not, however, break out then and there, the President (Mr. WEEKS) ruling, as might have been expected, that the change would not come into operation until the end of the fiscal year. It appears also to have been understood by many members that the resolution would have been submitted for confirmation before it became finally operative. However, on the following day, on the question of the locality where the next meeting should be held, the President remarked that *the new constitution being now in force he could not accept the votes of Associates.* This decision was opportunely delayed until after the votes had been taken, when it appeared that the exclusion of the Associates' vote would reverse the decision of the actual majority in favour of the locality whose claims happened to be supported by the President himself. It was then the row began.

THESE unhappy incidents may at some future day serve the purpose of a useful object lesson for ourselves. It seems likely enough that when the 474 central lighting stations now promised us are in operation somebody will begin to talk about having an Electric Lighting Association in this country. If, however, we are willing to profit by the experience of others, we shall know that the most sensible advice to give is—Don't. If, however, the rash experiment must still be tried, the next lesson would appear to be that dealers in electrical supplies should be rigidly excluded from the first. Lastly, we learn that in the choice of a Chairman it is well, if possible, to discover an individual who possesses the faculty of knowing his own mind.

A SECOND, and in some respects an even graver, scandal is occupying the attention of the American press. Our New York correspondent tells the story of "The Rise and Fall of HAROLD P. BROWN" so concisely that we do not need to recapitulate it here. We would, however, express the earnest hope that this exposure may lead to the repeal of the electrical execution law which the State of New York has been so ill-advised as to adopt.

Lancaster.—At the last meeting of the Lancaster Town Council it was decided to apply for an electric lighting Provisional Order.

The Electric Light at Drury Lane.—Drury Lane Theatre, which is at present undergoing extensive alterations, will be lit throughout by electricity.

Levenshulme.—At Levenshulme, a Manchester suburb, the Local Board decided last week to support the company who are applying for an Order for their district.

Lyons.—The Lyons Gas Company, which some little time ago embarked in the electric lighting business, is about to increase its plant capacity by 5,000 lights.

Ilkeston.—The Town Council at its last meeting unanimously agreed to oppose the application of the Midland House-to-House Electricity Company for a Provisional Order.

Royal College of Science, Dublin.—Particulars of the 1889-90 session of this college will be found in our advertisement columns. The session commences on the 7th October.

Stoke-on-Trent.—The Stoke-on-Trent Town Council, on the recommendation of the Parliamentary Committee, has resolved to oppose the introduction of any Bills dealing with electric lighting in the borough.

The Eiffel Tower.—The telegraphic apparatus upon the top of the Eiffel Tower was inaugurated on Monday morning last, and the first telegram transmitted by it was that of the Paris correspondent of the *Times*.

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The General Electric Company.—This company has secured the contract to supply all the electrical fittings, &c. (with the exception of the larger electroliers) for the installation of the electric light in the Government House at Shanghai.

Deaths from Lightning in France.—According to recent statistics, 653 people were killed in France from 1852 to 1882 by lightning. Of these, 487 were men and 166 were women. The majority of the deaths occurred in the open fields.

Adoption of the New Police Signal System.—The experiments with a new police signal system at Islington have resulted in its adoption by the Government. It is expected that the system will be extended to other parts of the metropolis.

Obituary.—The death is announced of Dr. Robert von Helmholtz at the early age of 28. The son of a distinguished father, he had already contributed a number of useful Papers to the scientific storehouse, most of them of practical value in meteorology.

Bacup.—The Corporation of Bacup have decided to oppose the application of the Lancashire and Cheshire House-to-House Electricity Company and the Municipal Electric Light and Power Corporation for Provisional Orders for the lighting of the borough.

The Electro-Harmonic Society.—We are requested by the honorary secretary to inform members that should their communications to him not receive the usual prompt reply, it will be in consequence of his absence from home during the meeting of the British Association.

Finsbury Technical College.—The courses of instruction of this college commence on October 8. Several scholarships, all tenable for two years, will be awarded on the results of the entrance examination. Further particulars will be found in our advertisement columns.

Harrogate.—A deputation waited upon the Corporation on Monday with a view of laying before them the advisability of lighting Harrogate by electricity, and of their intention, providing the Council agreed to the project, of seeking Parliamentary powers to accomplish it.

Sheffield.—The application from the Sheffield Telephone Exchange and Electric Light Company for the support of the Sheffield Corporation to their application to the Board of Trade for a Provisional Order will be considered at a special meeting of the Town Council on the 25th inst.

Brighton.—At a meeting of the Town Council last week the recommendations of the Pavilion Committee with regard to the electric lighting of that building, involving an expenditure of £544 for a set of 60 storage cells and alterations to the engine house, were adopted after a lengthy discussion.

Royal Cornwall Polytechnic Society. — The fifty-seventh annual Exhibition of this Society opened on Tuesday last. Several minor electrical exhibits were shown by Mr. W. H. Perrow, of Truro, Mr. W. G. Corse, of Devonport, Messrs. Cathcart and Peto, of London, and Mr. Barnicoat, of Northampton.

Tenders Wanted.—The Receiver for the Metropolitan Police district invites tenders for supplying, fixing, and maintaining electric cell calls at police stations for a period of three years from 1st October, 1889. Tenders must be sent in by the 21st inst. Further particulars will be found in our advertisement columns.

Repair of the Brest-St. Pierre Cable.—We are informed that the cable between Brest (France), and St. Pierre (Miquelon), laid in 1869, and broken in deep water on the 17th July last, was successfully repaired on the 5th instant by the company's steamship "Minia," Captain Trott, commander, and is now working well.

The Electric Light in Spain.—Barcelona advices state that the Gerona firm of Planas, Flaquer and Co., who were charged with the erection of the installation at Pamplona, have been instructed to supply Albacete and Teruel with a similar system of electric light. The Pamplona installation is reported to have given complete satisfaction.

Hawick.—The Town Council, by a majority of 10 to 3, have decided to support the application of the Scottish House-to-House Electricity Company on condition that the price of supply is moderate, that the works are substantial, and that the Council have the option of purchasing the whole concern at the end of every seven years at valuation.

Electric Traction at Florence.—The electric tramway between Florence and the neighbouring town of Fiesole is nearing completion. Its total length is about six miles, of which half consists of 7 per cent. gradients. The rails proceed along the common highway between the two towns. The system adopted is the Sprague with overhead conductors.

Military Telegraphy.—According to the *Bulletin International de l'Electricité* experiments will be carried out at the approaching manœuvres with a new telegraphic appliance. By the aid of an apparatus, which although structurally complicated is easy to manipulate, attempts will be made to reproduce at a distance drawings, plans, or rough maps.

Blackburn.—At a recent meeting of the Gas Committee of the Town Council, it was resolved that it be a recommendation to the Council to instruct the Parliamentary Committee to apply for a Provisional Order empowering the Corporation to supply electricity within the borough for public and private purposes on the lines of the Swansea Electric Lighting Order.

Electric Light Leads.—We have received from the Telegraph Manufacturing Company, of Helsby, some samples of their electric light leads, some of which are insulated with vulcanised and some with pure rubber. The samples range in size from a 19/12 to 1/20 cable, and are neatly secured in a red cloth case, which folds up compactly into the shape of a book.

Sales by Auction.—Our advertisement pages contain particulars of several sales by auction, the dates for which are close at hand. The two sales by Messrs. Wheatley Kirk, Price and Goulty take place on September 18th and 24th, and the sale of the London Stock of electrical fittings, &c., of Messrs. Winfields (Limited) by Mr. Scamell takes place on Monday next, the 16th inst.

Burton-on-Trent.—The Gas Committee of the Burton-on-Trent Town Council intimated, on Wednesday last week, that the manager's report as to the lighting of a portion of the borough by electricity had been laid before them, and they recommended that a statutory meeting of the Council should be held to consider the whole question of electric lighting. The report was adopted.

Birds Destroyed by Electricity.—At the recent meeting of the Zoological Society of France, M.M. Vian, Billard, and Petit presented a report on the subject of the wholesale destruction of swallows by electricity. In the South of France it seems that long wires are systematically erected along the seashore, and when the tired swallows alight on them they are stunned or killed by an electric shock.

A New Insulating Substance.—A by-product resulting from the treatment of asphalte with sulphuric acid, which has hitherto been considered of no value, has, says *La Lumière Electrique*, been found to furnish an excellent insulating material. This substance, which resembles ordinary asphalte, becomes, after exposure to great heat, as hard as ebonite or vulcanite, and possesses high insulating properties.

University College, Bristol.—The calendar of this institution, which is a compendious volume of over 200 pages, contains ample information with regard to the various classes and courses at the College. During the first and second terms Prof. J. Ryan will give a course of 20 evening popular lectures on "Electricity and Magnetism," as well as a systematic course of instruction in electrical laboratory work during the same period.

The Congress of German Naturalists.—The Congress of the German Naturalists (the equivalent of our British Association) is to be held in Heidelberg from September 18th to the 22nd. Simultaneously with the Congress there will be an exhibition of scientific apparatus, instruments, and preparations in the Gymnastic Hall of the town. Amongst the numerous Papers to be read is one by Hertz, on "The Relations between Light and Electricity."

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Edinburgh.—At a meeting of the Town Council on Monday, the notices of the proposed applications by the electric lighting companies for powers to light the city by electricity were considered. Lord Provost Boyd moved that the Council refuse their consent to the applications and remit the questions generally to the Lord Provost's Committee with powers to support any action that might be taken by the Gas Commissioners. The motion was adopted.

Reorganisation of the London Telephone Staff.—Owing to the new arrangements consequent upon the amalgamation of the telephone companies, Mrs. Beaufoy Merlin, who nine years ago started and organised the staff of ladies belonging to the service of the United Telephone Company, has resigned, and upon her retirement she was presented with a very handsome gold bracelet, and an address expressing the high esteem in which she was held by the large staff under her superintendence.

Mr. Edison in Paris.—The Town Council gave a banquet at the Hotel de Ville on Monday night, in honour of Mr. Edison, M. Chautemps, president, occupied the chair. Speeches were delivered by Mr. Sommerville Tuck, M. Alphand, M. Chautemps, and others. The guests afterwards made an inspection of the machinery in the basement, which supplies the Town Hall with the electric light. He was also entertained on Tuesday by the Society of Civil Engineers. Mr. Edison left Paris on Wednesday morning for Germany.

Telephonic Communication between Dundee, Edinburgh, and Glasgow.—The National Telephone Company have begun the erection of a trunk wire between Dundee and Glasgow. It has been arranged that the wire from Dundee—a metallic loop—will be run direct to Stirling. There will be a special metallic loop wire from Stirling to Glasgow, and another from Stirling to Edinburgh, which will be joined to the Dundee-Stirling wire as required, so that the new extension which has been begun will open up telephonic communication from Dundee, not only with Glasgow, but also with Edinburgh.

The Copper Market.—Visible stocks which reached their maximum, 124,876 tons in March last, have steadily decreased, and on August 31st amounted to 105,985 tons only; these last figures comparing with 86,701 tons on August 31st, 1888, and 51,206 tons a year earlier. The more conspicuous fact, however, is the price quoted for Chili bars—namely, £43. 10s., against £40. 2s. 6d. in August, 1887, when stocks were, as shown, less by more than one-half. Deliveries for the month reached 13,923 tons—the highest total during the three years—and exceeded the supply by 2,131 tons.

The Dutch Telegraph System.—According to trustworthy information, says *Industries*, the Dutch postal authorities will shortly introduce in the Netherlands the system of "slow" telegrams. Dutch inland messages will then be transmitted under three classes, as directed by the senders. There will be "urgent" telegrams, forwarded immediately in preference to ordinary telegrams, and at a special rate; "ordinary" telegrams, dispatched in the usual way, at the usual rate; and, finally, "slow" telegrams, which will cost very much less than ordinary telegrams, but which also will take a much longer time in reaching their destination.

University College, Liverpool.—The prospectus of this College for the 1889-90 session gives full details respecting the courses, classes, fees, scholarships, and other matters likely to be of use to intending students. We notice that there is a special curriculum for students preparing for a business life, the certificates granted at the close of the course to those who pass satisfactory examinations being held in high esteem by the mercantile firms of Liverpool. Amongst the numerous series of evening lectures will be one by Dr. Oliver Lodge, who will discourse during the autumn term on "The Functions of the Ether, or Recent Progress in Electricity."

Charterhouse Science and Art Schools and Literary Institute.—The winter session of this school will commence on Saturday, September 28th, under the presidency of the Rev. H. Swann, M.A. During the late session upwards of 1,200 students, mostly elementary teachers, availed themselves of the privileges afforded by this institution, and of this number about 750 presented themselves for examination, and were successful in obtaining a large number of first-class certificates, and also an unusually large number of honours certificates, awarded by the Science and Art Department of South Kensington. Instruction of a practical character is given in most of the sciences at a very moderate fee.

The Falmouth Gas Company and the Electric Light.—At the general meeting of the shareholders of this company held on Friday last, the chairman, in moving the adoption of the report, said that now electric lighting was making such strides throughout the country they thought the time had come when an Act should be obtained. They did not know exactly what would be required, but they were desirous of getting a Gas and Electric Lighting Act, and unless notice was given before November that they intended to apply for it they should be debarred from getting it before 1891. They asked the shareholders to give them the power to give notice for an Act of Parliament if it should be deemed necessary.

The Renard Primary Battery.—It is interesting to noet that the arc and incandescent lamps lighting the rooms of the Société d'Encouragement, on the occasion of the joint meeting of the Institution of Electrical Engineers and of the Société Internationale des Électriciens, were supplied with current from the chromic chloride batteries of Commandant Renard, which he has used in connection with his dirigeable balloon. A 300 candle-power arc lamp run off 36 cells was placed in the vestibule, and a 900 candle-power arc lamp run off 42 cells lighted the refreshment room, while 16 30 candle-power incandescents were used in the various rooms. Commandant Renard estimates the cost of the candle-hour when using his battery at one-fifth of a penny.

Exports of Telegraphic Apparatus.—The Board of Trade returns for August show that our exports of telegraphic wire, &c., last month were again very much below the corresponding exports in August, 1888, and August, 1887. Owing, however, to the very large shipments early in the year the value of the aggregate shipments to date, say 31st August last, is still much above the amount at the corresponding date of the two previous years. The following is a comparative statement of exports for the three years:—

	1887.	1888.	1889.
January 1 to June 30	£188,812	£244,213	£576,456
July	195,950	21,571	32,909
August	114,162	110,323	46,452
Eight months	£498,924	£376,107	£655,817

Electric Light in the House of Commons.—The London correspondent of the *Manchester Evening Mail* says:—"An opportunity will soon be afforded to contractors to light the Houses of Parliament by electricity. Up to the present time the authorities of the building themselves have had control of the small electric installation which exists, and has been completely successful in the hands of Mr. Prim, the resident engineer; but the Treasury seems to be unwilling to sanction the large expenditure necessary to light the whole of the palace. They therefore propose to call in the aid of some outside company, which will supply electricity at a fixed price per Board of Trade unit. No definite arrangements have as yet been made in this respect, and there is not likely, as far as can be seen at present, to be much competition for the contract."

The Terrors of the Telephone.—Attention is being called on the Continent to the effects produced by a continual use of the telephone. Thus, Dr. Gellé says in one case, that of a man of great intelligence, occupying a position which obliged him to listen sometimes almost incessantly to telephonic communications, the result was a state of nervous excitement, and hyperæsthesia of the hearing and of the ear itself, to such a degree that the sounds caused vertigo and ringing in the ears, and led to the persistence of alarming vertiginous sensations. Complete rest was sufficient to remove these troubles. In another case a young *employée* in a large establishment who had to attend to telephonic messages felt her ear becoming rapidly weak, and it was soon the seat of noises and of a remarkable hyperæsthesia, and at the same time the hearing became painful.

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Lomond's Pith Ball Telegraph in 1787.—The following curious reference to one of the many experimenters in pith-ball telegraphy is to be found in "Young's Travels in France," but does not seem to be generally known :—

"Oct. 16th, 1787.—In the evening to M. Lomond, a very ingenious and inventive mechanic. . . . In electricity he has made a remarkable discovery. You write two or three words on a paper, he takes it with him into a room, and turns a machine inclosed in a cylindrical case, at the top of which is an electrometer, a small fine pith ball; a wire connects with a similar cylinder and electrometer in a distant apartment, and his wife, by remarking the corresponding motions of the ball, writes down the words they indicate, from which it appears he has formed an alphabet of motions. As the length of the wire makes no difference in the effect, a correspondence might be carried on at any distance, within and without a beseiged town for instance. . . . Whatever the use may be, the invention is beautiful."

Hastings.—At the last meeting of the Town Council, the Lighting Committee recommended that application should be made by the Council for a Provisional Order authorising the supply of electricity for the following public purposes, viz.:—the lighting of streets or places and buildings belonging to or subject to the control of the Council in the borough, the exact area of supply to be determined on by the Committee. Mr. Jenner, in moving the adoption of the report, said that the Council was taking this course out of no spirit of opposition to the present Electric Lighting Company. The state of the case was simply that the Council would have with the dust destructor boiler power sufficient to work the machinery to produce their own electric light for public lighting, and the Surveyor had estimated that the saving which they would thus effect would be something like £180 a year upon the £450 now being paid for the lamps along the Front. They had no intention of supplying for private purposes, their object was simply to light the street lamps and anything else in connection with the Corporation. The motion was then carried.

Hampton Wick.—At the last meeting of the Hampton Wick Local Board the electric lighting question was considered, and it was announced that at the recent joint meeting of the Local Boards a resolution was drawn up which the representatives of each authority present agreed to accept. The heads of the agreement for obtaining the Provisional Order were :—1. That a Provisional Order should be obtained by the combined districts. 2. That the necessary capital for establishing the works should be provided according to the rateable value of each district. 3. That each of the local authorities forming the combination should be represented on the committee. 4. That each authority shall be entitled to representation on the basis of the rateable value. 5. That the committee so constituted shall have, and exercise, within the combined districts all the powers which an individual authority might exercise, each authority to bear its proportion of the expense. The resolution was "That this meeting will submit to the respective authorities in the district—the borough of Kingston, the Surbiton Improvement Commissioners, and the Local Boards of New Malden and Hampton Wick—that they shall combine for the purpose of making application for a Provisional Order to supply the districts with electricity, on the understanding that no district is to take a supply till it sees fit, and that the expense of obtaining such Provisional Order be defrayed by the combined districts in proportion to their rateable values." It was decided to discuss the matter at the next meeting of the Board.

Barnsley.—At the meeting of the Town Council on Tuesday, the Town Clerk reported that notices had been received by the Lighting Committee from three companies, the Municipal Electric Light and Power Corporation, the Yorkshire House-to-House Electricity Company, and the National Electric Supply Company, of intended applications for power to supply electricity in the borough. Since then he had had a letter from the National Electric Supply Company, stating that they should like to discuss the matter to learn whether the committee would co-operate in the lighting of an area in the district. Subsequently in another communication the company said that notices had been served in about 20 towns, but only five would be proceeded with this year. Negotiations with Leeds, Hull, and Bolton had already made considerable advance. They concluded by asking whether the Council would seek powers for themselves to supply electricity; if not, they asked permission to make a trial in the borough. Alderman Brady said he believed they ought to offer every reasonable facility to those who were able to supply the electric light. The question of public lamps was quite different. He was strongly of opinion that the Council should not apply for powers themselves, but they ought not to place an impediment in the way of public improvement coming to the town, which had already been too long delayed. He moved, "That the Town Clerk be directed to communicate with the National Electrical Supply Company, and inform them that the Council will offer no opposition to their taking steps for supplying electric light within the boundaries of the borough, subject to such arrangements as the Lighting Committee may suggest to the Council." Eventually the matter was referred to the Lighting Committee, who were empowered to take such steps as they thought proper and submit a report to next meeting.

Improvements in Railway Signalling.—Mr. Henry J. Peddie, of Edinburgh, has designed a method of railway signalling which is independent of fog or darkness. The apparatus is proposed to be used as an addition to the present means of signalling, and not as a substitute. There are two different appliances—the detector sound signal and locomotive safety steam cut-off and the railway train electric controller. The sound signal and steam cut-off consist of two parts, one attached to the sleepers and the other to the locomotive. The object is to stop a train should the engine driver not notice that the semaphore signal is at danger. Opposite the semaphore signal post a cast-iron shoe is fixed on a sleeper close to the rail. This shoe has two arms pivoted on it, and these are connected to each other and to a balance weight. They are also connected by a wire with the ordinary semaphore. When the latter indicates that the line is clear, the two arms are drawn down so that the apparatus on the locomotive passes clear of them. When the semaphore indicates danger the balance weight throws the arms up into a vertical position, in which they will catch and set in motion an apparatus fixed under the floor of the locomotive. This appliance, again, is so constructed that automatically it shuts off the steam in the engine, sounds the whistle, and applies the air brake to the whole train. Modifications of the arrangement admit of the whistle being sounded without the shutting off of the steam, and further, of its application to trains which are not supplied with the continuous brake. The other apparatus, which may be used instead, has the advantage of indicating to the signalmen in their boxes the point a train has at any time reached, and gives them control of the train during its entire journey. This electric controller involves two sets of apparatus. A battery or other source of electrical supply is placed in the signal-box. From it a conductor is led along the line to the signal post, or to the next station, or to any desired length. The conductor is a thin metal rail laid on wood between the usual rails, while one of the ordinary rails will serve as a return circuit. From the same battery wires are led to short conductors placed parallel with each other, but insulated, between the rails, at any desired distance apart. The plates of these conductors form the open poles of the electric circuit. A pendant wheel from the locomotive tender is so placed that it touches the conductors as the engine passes along. In so doing the wheel completes the circuit, an electric bell in the signal box is rung, and an indicator shows the point the train has reached. To the locomotive itself another pendant wheel is attached. It travels along the long conductor, and from the pendant wheel a wire is carried to an electro-magnet placed below an air or steam cylinder. In the event of a train passing a signal at danger an intimation of the fact is conveyed to the signalman in the box, who will set a danger signal. The effect of this will be to set in motion apparatus which will shut off the steam in the advancing engine, sound the whistle, and apply the brake to the whole train. In short, the signalman has at all times complete control over a train. Various modifications and simplifications are suggested by the patentee for different cases, and a similar apparatus is applicable to mines.

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THE PARIS EXHIBITION.

Prof. Elihu Thomson's Personal Exhibit.

This interesting exhibit is in the United States Section of the Industrial Courts. It consists partly of machines and instruments of a practical character, and partly of apparatus for illustrating alternate-current phenomena, some of the latter being those employed by Prof. Thomson in his recent researches which were described in *The Electrician*, Vol. XIX., p. 104.

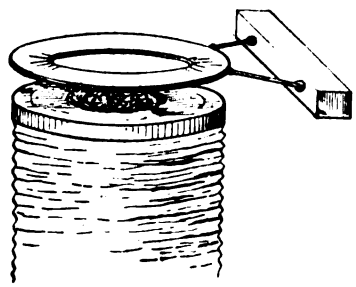

Fig. 1.

Among the latter description of apparatus is a coil, shown in Figs. 1 to 3; it stands about a foot high, has a core made up of pieces of iron wire, and is wound to carry a current up to

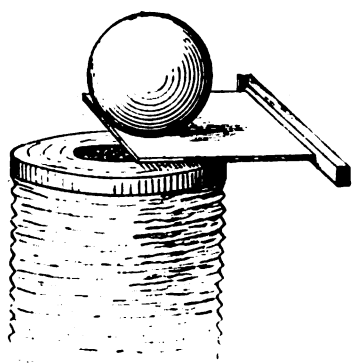

Fig. 2.

40 amperes. Power is supplied from the Thomson-Houston stand in the Palais des Machines for showing the experiments with this coil, and also for working the machine and instruments in the exhibit.

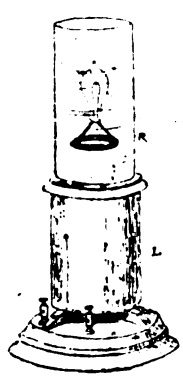

Fig. 3.

Amongst other remarkable experiments* which may be made with the coil alone, we may describe the following:—If a light metal ring is held over the coil while an alternating current is passing round it, the ring is thrown up into the air when released. When a ring attached to a holder to prevent lateral motion is placed on the top of the coil (Fig. 1) the force of repulsion will keep it suspended in the air about the coil. A hollow copper ball, if placed on the top of the coil, immediately runs off, but if partially shielded by a metal plate on the edge of which it is placed (Fig. 2), it begins to spin round; the direction of motion varies with its position, the unshielded part tending to turn towards the core.

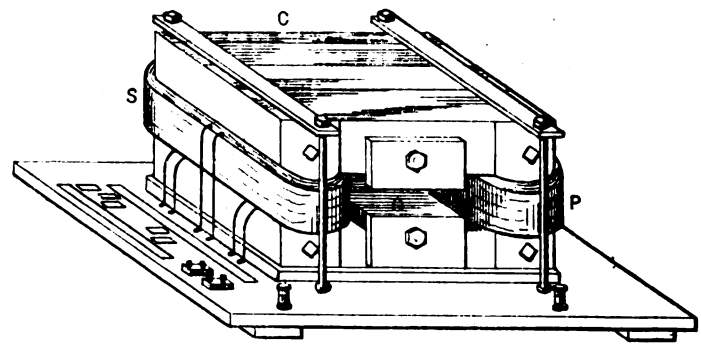

Fig. 4.—Elihu Thomson's Constant-Current Transformer.

Another experiment is illustrated in Fig. 3. Here an incandescent lamp is joined up in circuit with a ring-shaped coil of insulated wire, R, and placed in a vessel of water over the large coil, L, carrying the alternating current. The lamp is illuminated by the currents induced in the ring, and at the same time the repulsion causes both to rise in the water. The light

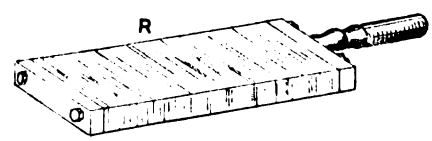

Fig. 4*a*.—Regulator used in connection with the Constant-Current Transformer.

given by the lamp naturally depends to some extent upon the depth at which it is floating. If the copper ball is placed in the water it is also repelled upwards, and made to rotate at the same time.

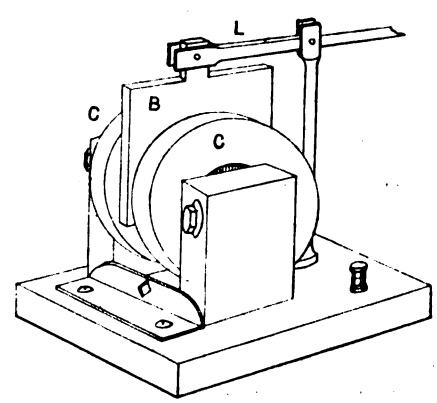

Fig. 5.

Among the practical appliances is a constant-current transformer, shown at Fig. 4. This is made up of a laminated iron core, C, having the primary coil P wound upon one side of the arc, and the secondary S on the other. The magnetic circuit is, however, almost short-circuited in the centre G, where the opposite sides of the core approach each other very closely. The gap can, however, be still further diminished by inserting the regulator R (Fig. 4*a*), which consists of a number of small

* All or nearly all these experiments are based upon the possibility of producing a powerful repulsive effect betwixt two circuits, one of which is traversed by an alternating, whilst the other circuit, which is usually of low resistance, is subject to the inductive influence of the first. The reason for the observed repulsion was first clearly explained by Dr. J. Fleming (in *The Electrician*, of May 6, 1887), who also independently discovered the effect at or about the time of its discovery by Prof. E. Thomson.

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plates attached to a handle. The total number of lines passing through the secondary can thus be diminished to any required extent by inserting R to a suitable distance within the gap G, and in this way a certain crude regulation is obtainable. The device is obviously of little practical value.

The "reactive" coil illustrated in connection with the description of the Thomson Electric Welding Company's exhibit (*The Electrician*, August 30) is also shown at this stand.

Another repulsion effect is shown in the piece of apparatus illustrated in Fig. 5; it has received a practical application as the regulator of an arc lamp. The current passes round the coils C C, and on reaching a certain strength causes the plate B, attached to the lever L, to rise from its position between the coils. When inserted into an arc lamp the mechanism is arranged as follows. The wheels and pinions which gear into the rack rods carrying the carbon holders are fixed into a light frame suspended by links, like a Watts parallel motion, the rod

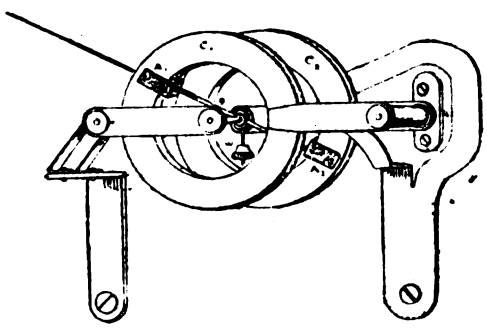

Fig. 6.—Elihu Thomson Ammeter.

L being one of them. When the current in the coils C C, which are connected up as a shunt to the carbons, becomes strong, the brass plate is repelled upwards causing the other end of L to fall, and with it the frame above mentioned, thereby liberating one of the wheels from a catch rigidly fixed about it, and allowing the carbon rods to run down.

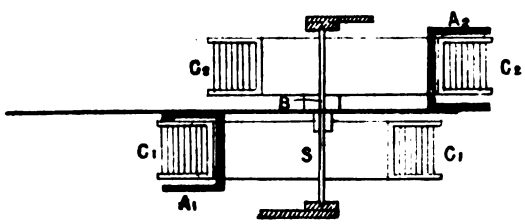

Fig 7.—Elihu Thomson Ammeter (Plan).

Among the instruments designed and invented by Prof. Thomson are one or two forms of the meter that was described in *The Electrician* of May 24, 1889, p 60. At the Thomson-Houston stand one of these may be seen working regularly on one of the incandescent lamp circuits.

A new form of ammeter and voltmeter is shown in Figs. 6 and 7. Two coils, C_1 C_2, are fixed in a vertical position as shown, and wound with copper tape or fine wire, according to the purpose for which they are to be used. Two soft iron shoe-shaped armatures, A_1 and A_2, are fastened at either end of a light arm, B, attached to a spindle, S, which is free to turn in light bearings. The coils and spindle are set with their axes parallel, but not in the same straight line, as will be noticed from the plan, Fig. 7. In other words, the spindle is pivotted excentrically to either coil. When a current flows round the coils the armatures tend to move round, the amount being indicated by the pointer, which is a continuation of the arm B. It is a gravity instrument, the movement being controlled by the adjustable weight W. For very large currents one coil only is used, having only one turn, the action being the same as with the two coils. It is obvious that the instruments may be used either for continuous or for alternating currents.

Besides the above, there is a voltmeter constructed on the electrostatic principle. Its working parts consist of two pairs of cheeks, fixed one behind the other, the front pair being attached to the frame of the instrument, and the back pair suspended on light bearings, with a pointer attached to them. The two pairs of cheeks are insulated from one another, and one pair is attracted towards the other according to the difference of potential between them. The instrument closely resembles the electrostatic voltmeter designed by Sir William Thomson.

Two alternate-current motors are also exhibited. Both work more or less on the same principle, viz., that of the repulsion between an electro-magnet carrying an alternating current and another coil that is short-circuited, as illustrated by all the ex-

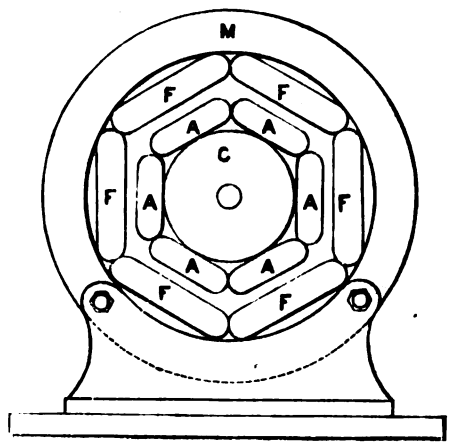

Fig. 8.—Elihu Thomson Alternate-Current Motor.

periments previously mentioned. The general construction of one of these motors will be gathered from the sketch, Figs. 8 and 8*a*. Six coils, F, are fixed inside a laminated frame, M, and form the field magnets. The armature consists of a core, C, with six similar coils, A, attached to it; the form of these coils is shown in Fig. 8*a*. The current passes through the field-magnet coils F, which are wound in opposite directions, then by way of a commutator through the armature coils. This commutator, however, only comes into action when the machine is started, the brushes being short-circuited as soon as the motor has attained its proper speed;

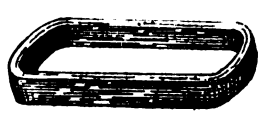

Fig. 8*a*.—Armature Coil of the Elihu Thomson Alternate-Current Motor.

it is fixed at the end of a hollow spindle, like those of the Thomson alternating dynamo, but has an arrangement inside by which two contacts fly out (by centrifugal force) and short-circuit the armature coils when the motor increases its speed. The stops against which the brushes come when they are short-circuited also have the effect of lifting them from the commutator. By means of this device the machine is made self-starting. The other motor was described and illustrated in *The Electrician* for August 2, p. 321.

The Edinburgh Exhibition.—At the last meeting of the Executive Council the catalogue was agreed upon. It is divided into three divisions. Division I.: Electrical Engineering and inventions, contains six sections, namely:—Section I.: Production of electricity; II.: Electrical conductors; III.: Measurements; IV.: Application of electricity; V.: Bibliographic collection of works relating to electricity, plans, drawings, &c.; VI.: Historical collection. The other two divisions are:—II.: General inventions and industries, and includes sixteen sections; III.: Fine arts.

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PARIS INTERNATIONAL ELECTRICAL CONGRESS.

(FROM OUR SPECIAL CORRESPONDENT.)

Saturday, August 31.

This evening the French members of the Congress entertained their foreign colleagues at a banquet at the Hotel Continentale. The gathering was large and brilliant, about 350 covers being laid. M. Mascart presided, with Sir William Thomson on his right hand, Mr. Preece on his left, and M.M. Cochery and Berger next them. The "*carte du menu*" was elaborately designed with symbolic electrical representation referring to Volta, Faraday, Ruhmkorff, Ampère, Oersted, Gauss, Ohm, Galvani, Gramme, Jamin, Foucault, Daniell, Bunsen, Joule, Siemens, Graham Bell, Edison, Becquerel, and Wollaston. The French have too much respect for "*la cuisine*" to tolerate any joking with respect to the eatables, and there appeared on the *menu* no "*potages électriques*," "*côtelettes Jablochkoff*," or "*salade Edison*." M. MASCART proposed the health of M. Cochery, ex-Minister of "*Postes et Telegraphes*" in a humorous speech, in which he said M. Cochery has been made an electrician by force ("*electricièn par nécessité*"), much to the advantage of his countrymen and of science, and hinted that the success of the Congress was due to M. Cochery's genius in securing "unanimity." This was a side-poke at M. Cochery's reputation for securing votes at meetings "*nem. contradicente*" by the simple device of leaving no time for anyone to speak before asking for a show of hands.

In replying, M. COCHERY expressed his earnest hope that the International Society of Electricians would be universally supported by the adherence of scientists in all countries. M. BERGER spoke next, and said it was the desire of the organisers of the Exposition to offer a world-wide hospitality, and in their name he offered a welcome to the guests of the evening, not only on behalf of French science, but also on behalf of France herself.

In replying to this speech on behalf of the foreign guests, Sir WILLIAM THOMSON, who was greeted with hearty and repeated cheers, said that during the past week the meetings of the Congress had been to him a source both of pleasure and of profit. In the name of his own countrymen and of all the other foreigners present, he tendered to the President and to his colleagues heart-felt thanks for the hospitality and the kindness that had been shown them in every direction. For his own part, a feeling of profound gratitude had been implanted in his mind which would never be effaced from his memory. Paris had always appeared to him the natural centre for cosmopolitan gatherings of this sort—it was the capital of science, the place where all could meet on common ground and show each other international friendship. There was something about Paris that made these Congresses that had been held here peculiarly pleasant. For them, and for the strangers from all parts of the world who had joined with them, it seemed to be the home of concord and "*unanimity*," and the "happy land." This Congress had not been less agreeable or less successful than its predecessor in 1881. Not only for science itself and for the interests of the workshop, but also for results beneficial to the world at large, the work of this Congress would be gratefully remembered. He hoped it would not be the last time we should meet here. Among all countries France takes the first place for hospitality to people from every part of the world, and for skill in the organisation of such affairs as those with which we have been occupied during the past week, and he hoped she would long continue to hold the position she had so gracefully assumed as the rendezvous of the Congress of the world.

As he sat down, the enthusiastic cheers with which Sir William had been received were again and again repeated.

M. TOURITINIER, of Geneva, was the next speaker, and then M. STOLETOW proposed the health of M. Mascart, a toast that was very cordially received.

M. ABDANK-ABAKANOWICZ then spoke in eulogy of those who had conceived the idea of the Congress of 1881, and had carried it out so much to the benefit of science. In the name of the Electrical Engineers of America he cordially invited the electricians of the Old World to the projected Congress in connection with the New York Exhibition of 1892.

The company then adjourned to another and cooler hall for the purpose of discussing the events of the week in an informal fashion over their coffee and cigars.

Thus has ended a Congress which has certainly been a very pleasant *réunion*, and which in some respects will be remembered as as important one. Its importance cannot for a moment be compared to that of 1881. There have been several influences tending to lower the effect it might otherwise have had. The first of these is that congresses this year are at a discount. There has been such a deluge of congresses in connection with this Paris Exhibition—congresses of all sorts: of millers, greengrocers, and firemen, as well as of politicians, literary men, and scientists—that the public has lost count of them, and cannot pay any attention to them. During this week the congress of "*pompiers*" (firemen) attracted much more public attention in Paris than did the Electrical Congress, it being accompanied by grand displays on the boulevards. Among the general public our Congress has stimulated as little thought as if it had not been held, and it would be the most foolish and priggish affectation to imagine that the influence and authority of the Congress has not thereby been greatly diminished.

In the second place, Germany has been practically unrepresented, and, in spite of Sir W. Thomson's presence, it must be frankly confessed that there was so small a number of English electricians present that they could not be taken as authentically, or, at any rate, in any complete way, representing the intelligence of our own country. The American representation was also notably weak. Again, it can hardly be said that the business of the Congress was at all sufficiently or well prepared, or that it was well regulated in the course of the proceedings. Much time was taken up in discussions, whose proper place should have been the different local or national societies. The really great questions of world-wide interest and importance were allowed to be thrust aside to a great extent by these comparatively unimportant proceedings, and were in some cases simply left alone, and in others decided upon after absurdly short and insufficient deliberation.

Fortunately, most of the leading decisions of the Congress merely formally ratify what has already been long established by general agreement. The case would have indeed been bad for the authority and influence of the Congress if it had stultified itself by presuming to decree a three-minutes' limit for telephonic conversations. If it had done that, it would have very soon become apparent what little reality such a pretension to international authority it possessed. As regards the adoption of the name "quadrant" for unit coefficient of self-induction, it was unfortunate that there was no one there to defend the term "secohm." Whatever objection may be taken to this latter, it has, at any rate, an evident electrical meaning, whereas "quadrant" is absolutely unmeaning in the connection in which the Congress has placed it. It is *not* the quadrant of the earth's surface, and if it were, that fact could have no logical influence in the solution of the problem of the choice of the best terms by which to describe the phenomena of self-induction. Nevertheless, we desire frankly and fully to acknowledge the utility and importance of this meeting; to express also the hope that its decisions will meet with general support, and, finally, to record our grateful appreciation of the great kindness and hospitality of our French hosts.

CONTRIBUTIONS TO THE CHEMISTRY OF STORAGE BATTERIES.*

BY E. FRANKLAND, D.C.L., F.R.S.

Under this title I communicated to the Royal Society, in February, 1883,† the results of some experiments on the reactions occurring during the charging and discharging of a storage cell. I showed that no appreciable part of the storage effect was due to occluded gases, as had been previously suggested by some chemists and physicists; but that the act of charging consisted essentially in the decomposition of lead sulphate, whilst the discharge was produced by the recomposition of this salt.

* A Paper read before the Royal Society, June 20, 1889.

† *Proceedings* of the Royal Society, Vol. XXXV., p. 67.

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The establishment of these, as practically the only reactions going on in a storage cell, enabled me to prescribe a very simple method by which the charge in any cell could be ascertained, for as sulphuric acid is liberated during the charging and absorbed by the active material of the plates during discharge, the amount of charge could at any time be measured by ascertaining the amount of free sulphuric acid in the cell; in other words, by simply determining the specific gravity of the electrolyte; and this method has since been very generally adopted by the users of storage batteries.

In continuing these experiments it soon became evident that the lead sulphate formed and decomposed in the cell could not be the ordinary white sulphate hitherto known to chemists, because, in the first place, the active material of the plates always remains coloured, even after discharge; and, secondly, because whenever white sulphate is produced through abnormal reactions in the cell, it is afterwards decomposed only with extreme difficulty by the electric current.

In order to obtain some light upon the composition of the sulphate formed and decomposed in the cell, I have studied the action of dilute sulphuric acid upon litharge and minium.

Action of Dilute Sulphuric Acid on Litharge.

Finely-powdered litharge was treated with successive portions of dilute sulphuric acid until the liquid remains strongly acid after prolonged trituration. The resulting insoluble buff-coloured powder was washed with water till free from acid, and dried first at 100°C. and afterwards at 150—160°. The loss at this higher temperature was less than 0·2 per cent., and was therefore due to hygroscopic moisture.

PbO and SO_3 were then determined in the dried compound as follows:—The salt was dissolved in a small quantity of pure concentrated solution of caustic potash, and the solution, after dilution, was saturated with CO_2. (According to H. Rose, COPbo″ is soluble in $COKo_2$, but not in COHoKo.) Any excess of CO_2, which might have caused the COPbo″ to dissolve, was avoided by warming the liquid with the precipitate on the water-bath to a temperature at which the COHoKo begins to dissociate. The liquid was then allowed to cool and stand twelve hours before filtering. The COPbo″ was filtered off, converted into nitrate, and precipitated and weighed as sulphate. The sulphuric acid was determined in the filtrate from the COPbo″.

1·2964grms. of the salt gave 0·6647grm. baric sulphate and 1·4437grms. plumbic sulphate.

These numbers agree closely with the formula—

$$(^{c}_{3}(SO\,(PbO)_5,$$

as is seen from the following comparison of calculated and experimental numbers:—

	Calculated.		Found.
$3SO_3$	240	17·71	17·61
$5PbO$	1115	82·29	81·96
	1355	100·00	99·57

These analytical results suggest the following graphic formula:—

$$\begin{array}{ccccc} PbO_2 & & PbO_2 & & \\ \| & & \| & & \\ S=O_2= & S & =O_2= & S & \\ \| & & \| & & \| \\ PbO_2 & & PbO_2 & & PbO_2 \end{array}$$

The formation of this salt may be represented by the following equation:—

$$\underset{\text{Litharge.}}{5\,PbO} + \underset{\text{Sulphuric acid.}}{3\,SO_4H_2} = \underset{\text{Buff lead salt.}}{S_3Pb_5O_{14}} + \underset{\text{Water.}}{3OH_2}.$$

Action of Dilute Sulphuric Acid on Minium.

Minium was treated with dilute sulphuric acid in exactly the same way as litharge, and the resulting brownish-red compound dried first at 100° C. and afterwards at 150—160°. The loss at this higher temperature was again less than 0·2 per cent.

PbO, SO_3, and excess of oxygen were then determined in this salt in the following manner:—The salt was first treated with concentrated hydrochloric acid in order to reduce all the lead to the non-oxide stage. The resulting mixture was then dissolved in caustic potash and treated as already described. The excess of oxygen was determined by finding the loss of weight which resulted from the evolution of CO_2 when the salt was treated with oxalic acid and dilute nitric acid.

2·1136grms. of the salt gave 1·1978grms. baric sulphate and 2·2710grms. lead sulphate.

1·5110grms. treated with oxalic acid and dilute nitric acid evolved 0·0910grm. CO_2.

These numbers correspond to the following percentages:—

SO_3	19·45
PbO	79·03
O	1·09
	99·57

which agree with the formula—

$$S_2Pb_3O_{10},$$

as is seen from the following comparison:—

	Calculated.		Found.
S_2	64	7·57	7·78
Pb_3	621	73·49	73·36
O_{10}	160	18·94	18·43
	845	100·000	99·57

The composition of this salt may be represented graphically, thus:—

$$\begin{array}{ccccc} & & O & & \\ & & \| & & \\ Pb & =O_2=S= & O_2= & Pb & \\ & =O_2=S= & O_2= & Pb & \\ & & \| & & \\ & & O & & \end{array}$$

The formation of this salt is expressed by the following equation:—

$$\underset{\text{Minium.}}{Pb_3O_4} + \underset{\text{Sulphuric acid.}}{2SO_4\,H_2} = \underset{\text{Red lead salt.}}{S_2Pb_3O_{10}} + \underset{\text{Water.}}{2OH_2}.$$

These, then, are the salts which constitute the original active material of storage cells when that material is formed by the admixture of sulphuric acid with litharge or minium respectively, and it is highly probable that one or the other of these salts takes part in the electrolytic processes of the storage battery. It is fortunate that these hitherto unknown salts (and not the ordinary known sulphate) are formed in the cell reactions; for, in the alternative case, lead storage batteries would be practically valueless.

If the buff lead salt be the active material of the battery plates, then the following equations express the electrolytic reactions taking place in the cell:—

I. In charging—

(*a*). *Positive Plates.*

$$\underset{\text{Buff lead salt.}}{S_3Pb_5O_{14}} + \underset{\text{Water.}}{3OH_2} + O_5 = \underset{\text{Lead peroxide.*}}{5PbO_2} + \underset{\text{Sulphuric acid.}}{3SO_4H_2}.$$

(*b*). *Negative Plates.*

$$S_3Pb_5O_{14} + 5H_2 = 5Pb + 3SO_4H_2 + 2OH_2.$$

II. In discharging—

(*a*). *Positive Plates.*

$$5PbO_2 + 3SO_4H_2 + 5H_2 = S_3Pb_5O_{14} + 8OH_2.$$

(*b*). *Negative Plates.*

$$5Pb + 3SO_4H_2 + O_5 = S_3Pb_5O_{14} + 3OH_2.$$

If the red lead salt be the active material, then the following equations express the same electrolytic reactions:—

I. In charging—

(*a*). *Positive Plates.*

$$\underset{\text{Red lead salt.}}{S_2Pb_3O_{10}} + O_2 + 2OH_2 = \underset{\text{Lead peroxide.}}{3PbO_2} + \underset{\text{Sulphuric acid.}}{2SO_4H_2}.$$

(*b*). *Negative Plates.*

$$S_2Pb_3O_{10} + 4H_2O = 3Pb + 2SO_4H_2 + 2OH_2.$$

II. In discharging—

(*a*). *Positive Plates.*

$$3PbO_2 + 2SO_4H_2 + 2H_2 = S_2Pb_3O_{10} + 4OH_2.$$

(*b*). *Negative Plates.*

$$3Pb + 2SO_4H_2 + 2O_2 = S_2Pb_3O_{10} + 2OH_2.$$

An inspection of these equations discloses, in the case of the red lead salt, a fact which has already been roughly observed in practice, viz., that only half as much active material is electrolytically decomposed on the negative as on the positive plates; whence it follows that the weight of active material on the negative plates need not exceed one-half of that upon the positive plates; for, in the decomposition of the electrolyte, equivalent quantities of oxygen and hydrogen are evolved—that is to say, two atoms of hydrogen for each atom of oxygen. But in the decomposition of the red lead salt four times as many atoms of hydrogen are required to reduce the salt to metallic lead as atoms of oxygen which are necessary to transform the lead of the salt into peroxide. When, however, the active material of the positive plate has once been converted into peroxide of lead, it seems probable that the red salt only is formed; at all events, until the discharge at high potential is nearly completed, when there are indications of the production of the buff-coloured salt. But this is a point requiring further investigation.

I have to thank Dr. F. R. Japp, F.R.S., for his assistance in the analytical work of this investigation.

* Mr. Fitzgerald considers that this peroxide is hydrated.

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THE POSTMASTER-GENERAL'S REPORT.

Whatever may be thought of the financial position of the Telegraph Service, there is but one opinion as to its efficiency and its extraordinary development since it came into the hands of the Post Office. Not only have the charges been greatly reduced, but the facilities for the transmission of telegrams have in every way been enormously enlarged. According to the POSTMASTER-GENERAL'S Report just published for the year ended the 31st March, 1889, the number of offices at which telegraph business can now be transacted in the United Kingdom exceeds seven thousand, and they are being constantly increased. Looking at the figures representing the extent to which the public have taken advantage of these privileges during the nineteen years the telegraphs have been under Post Office management, we find that the amount of inland telegraphic business is nearly six times what it was at the beginning of that period. Commencing with less than ten million messages per annum, the numbers have gradually risen to little short of fifty-eight million, generally by progressive leaps of from one and a-half to three millions each year. In the year 1886-87, when the tariff, which was reduced from 1s. to 6d. in the October previous, had been in operation during the whole twelve months, there was a remarkable bound from thirty-nine millions to fifty millions; but in the two years succeeding, the increase has been at the rate of about three and a-quarter and four and a-quarter millions respectively. This is approximately the rate at which the number of telegrams increased during the first few years of the shilling tariff, between 1870 and 1873. After then the normal increase settled down to two millions, or thereabouts: and it seems not unlikely that the progressive increase which has taken place under the sixpenny tariff since the autumn of 1885 will be subject to a similar law. The

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figures are worth noting carefully, as affording some indication of the financial results of that experiment.

As regards its public utility there can be no question that the sixpenny tariff has been a great success. If the present rate of increase be maintained, at the end of the current financial year the number of telegrams will have nearly doubled since 1885, a fact which thoroughly justifies the sanguine expectation of those who were responsible for introducing the last great reform of telegraph charges on the grounds of public convenience. Of the financial situation, however, as the POSTMASTER-GENERAL reminds us, we cannot speak with the same confidence. For one thing, the public appear to have mastered the lesson of brevity, which the department set them to learn in 1885, perhaps a little too cleverly. It was thought that although the addresses would be materially curtailed the message as a whole would not be very greatly reduced. But the public have taken the sixpenny tariff literally, and are rapidly acquiring the habit of getting their money's worth within the compass of the initial rate. Year by year the average price paid for each telegram is being gradually reduced; and as every separate transaction costs the department a definite sum irrespective of the size of the message, it is easy to see that an increase in the amount of business done, represented by an increased number of messages, will not, at this rate, bring a proportionately increasing sum to the revenue. Again, the senders of Press messages, by availing themselves more largely of the privilege of sending copies of the same telegram to several newspapers, are occupying the wires more than ever without adding anything to telegraph receipts; and as this class of business is said to be unremunerative at the best, its increase cannot be regarded as satisfactory from a financial point of view. Mr. RAIKES very properly again draws attention to the continued growth of free messages sent by the Railway Companies under an agreement with them when the telegraphs were acquired by the Post Office. These messages, numbering over a million per annum, are a dead loss, and until the bargain is cancelled or commuted, must continue to be so. Taking all these considerations into account, and the fact that every year's increase of business must be met by augmented staff, enlarged accommodation, and additional plant and apparatus, the net profits of the telegraph service cannot be expected to keep pace with the increase of messages.

The gross receipts for 1888-9 amounted to £2,129,669, against £1,992,949 for 1887-8; but the expenditure also has risen from £1,999,033 to £2,042,394 in the same periods; and although the deficit, taking into account the interest on capital, is less than it has been since 1882-3, it stands at the respectable sum of £239,142—a sum which at the present rate of net profits it will take several years of prosperity to wipe out. It is often complained that this annual interest, amounting to £326,417, on the original purchase-money continues to be placed to the year's account, and it is urged that if the expenditure on extensions and accommodation were treated in the same way instead of being charged to expenditure, the telegraphs would be working at a profit. The rule of public departments, however, is to charge such items to the year's account, for the very excellent reason that this is probably the only way of checking extravagant expenditure where there are no shareholders to be consulted. We think it an excellent rule, and the departure from it in the case of the large sum expended on the purchase of the telegraphs ought not to be taken as a pretext for a similar course in respect to expenditure which in ordinary commercial business would be placed to capital account. Whether it is expedient to keep on debiting the telegraph service year after year with the interest on the original outlay is another matter. But clearly the financial critics cannot have it both ways; for if the annual capital expenditure were charged to capital account, the first capital outlay also must be so treated, and in that case the whole accumulated arrears of interest would stand against the telegraph service, and this could never be paid off within measurable distance of time. Probably the requirements of the case will be met when the telegraphs are able to pay interest on the purchase-money with a small margin to the good; and this we may hope they will do at no very distant date, though not so soon as some prophets asked us to expect.

All predictions on that point, however, are rendered uncertain by the change which has this year taken place in the relations of the Post Office with the Anglo-European cable systems. On the 1st April the Submarine Telegraph Company's business was acquired jointly by the Governments of England, France, and Belgium, the German Government purchasing at the same time the cable of the German Union Company. The terms of purchase were, to say the least of it, extremely easy; the rates between England and the Continent have been reduced; the speed of working already has been greatly increased, and it is known that the traffic is rapidly growing. The arrangement is not altogether what we should have liked for this country; but considering the international jealousies involved, it was, perhaps, the best that could be made, and undoubtedly it ought to be a source of considerable revenue to the English telegraph department. Next year's report will be looked forward to with some interest in this relation. Our share in the transaction cost £67,163; and this sum, we suppose, will be placed to the current expenditure account, in compliance with the rule referred to above. Nevertheless it will surprise us if the net balance is materially diminished by that proceeding; in other words, we expect that the profits of the undertaking will in a very short time more than cover the small sum invested in taking it over. No mention is made by the POSTMASTER-GENERAL of his recent correspondence with the Telephone Companies; but the language he employs in respect to the Submarine Telegraph Company is significant of his general policy with regard to telegraphs outside the jurisdiction of the State.

ON THE PROPAGATION OF ELECTRIC WAVES THROUGH WIRES.

BY PROF. H. HERTZ.*

If a constant electric current flows in a cylindrical wire, its intensity is the same in all parts of the section of the wire. But if the current is variable, self-induction causes a deviation from this most simple distribution. For, since the inner parts of the wire are in the mean less distant from all the rest than are those on the circumference, induction opposes alterations of the current in the interior of the wire more strongly than at the circumference; and in consequence of this the flow is confined to the exterior of the wire. If the current alters its direction a few hundred times per second the deviation from the normal distribution is no longer imperceptible; this deviation increases rapidly with the rate of alternation, and when the current alternates many millions of times per second, according to theory almost the whole interior of the wire must appear free from current, and the flow must be confined to the immediate neighbourhood of the circumference. In such very extreme cases the hitherto accepted theory of the phenomenon is plainly not without physical difficulties; and preference must be given to another view of the subject, which was indeed first put forward by Messrs. Heaviside† and Poynting‡ as the true interpretation of the equa-

* From the *Phil. Mag.* for August. Translated from Wied. *Ann.*, XXXVII., p. 395 (July, 1889), by Dr. J. L. Howard, Demonstrator of Physics in University College, Liverpool.

† Oliver Heaviside, *The Electrician*, Jan., 1885; *Phil. Mag.* [5], XXV. p. 153 (1888). ‡ J. H. Poynting, *Phil. Trans.*, II., p. 277 (1885).

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tions of Maxwell as applied to this case. According to this view, the electric force which determines the current is in no wise propagated in the wire itself, but under all circumstances enters the wire from without and spreads itself in the metal comparatively slowly, and according to similar laws as changes of temperature in a conductor of heat. If the forces in the neighbourhood of the wire are continually altering in direction, the effect of these forces will only enter to a small depth into the metal; the more slowly the changes take place, so much deeper will the effect penetrate; and if, finally, the changes follow one another infinitely slowly, the force has time to fill the whole interior of the wire with uniform intensity.

In whatever way we wish to regard the results of the theory, an important question is, whether it agrees with fact. Since, in the experiments which I carried out on the propagation of electric force, I made use of electric waves in wires which were of extraordinarily short period, it was convenient to prove by means of these the accuracy of the inferences drawn. In fact, the theory was proved by the experiments which will now be described; and it will be found that these few experiments suffice to confirm in the highest degree the view of Messrs. Heaviside and Poynting. Analogous experiments, with similar results, but with quite different apparatus, have already been made by Dr. O. J. Lodge,* chiefly in the interest of the theory of lightning conductors. Up to what point the conclusions are just which were drawn by Dr. Lodge in this direction from his experiments must depend in the first place on the velocity with which the alterations of the electrical conditions really follow each other in the case of lightning.

The apparatus and methods which are here mentioned are those which I have described in full in previous memoirs.† The waves used were such as had in wires a distance of nearly 3 meters between the nodes.

1. If a primary conductor acts through space upon a secondary conductor, it cannot be doubted that the effect penetrates the latter from without. For it can be regarded as established that the effect is propagated in space from point to point, therefore it will be forced to meet first of all the outer boundary of the body before it can act upon the interior of it. But now a closed metallic envelope is shown to be quite opaque to this effect. If we place the secondary conductor in such a favourable position near the primary one that we obtain sparks 5 to 6 millimetres long, and surround it now with a closed box made of zinc plate, the smallest trace of sparking can no longer be perceived. The sparks similarly vanish if we entirely surround the primary conductor with a metallic box. It is well known that with relatively slow variations of current the integral force of induction is in no way altered by a metallic screen. This is, at the first glance, contradictory to the present experiments. However, the contradiction is only an apparent one, and is explained by considering the duration of the effects. In a similar manner a screen which conducts heat badly protects its interior completely from rapid changes of the outside temperature, less from slow changes, and not at all from a continuous rising or lowering of the temperature. The thinner the screen is the more rapid are the variations of the outside temperature, which can be felt in its interior. In our case also the electrical action must plainly penetrate into the interior, if we only diminish sufficiently the thickness of the metal. But I did not succeed in attaining the necessary thinness in a simple manner; a box covered with tinfoil protected completely, and even a box of gilt paper, if care was taken that the edges of the separate pieces of paper were in metallic contact. In this case the thickness of the conducting metal was estimated to be barely $\frac{1}{20}$ millimetre. I now fitted the protecting envelope as closely as possible round the secondary conductor. For this purpose its spark-gap was widened to about 20 millimetres, and in order to detect electrical disturbances in it an auxiliary spark-gap was added exactly opposite the one ordinarily used. The sparks in this latter were not so long as in the ordinary spark-gap, since the effect of resonance was now wanting, but they were still very brilliant. After this preparation the conductor was completely enclosed in a tubular conducting envelope as thin as possible, which did not touch it, but was as near it as possible; and in the neighbourhood of the auxiliary spark-gap (in order to be able to use it) the envelope contained a wire-gauze window. Between the poles of this envelope brilliant sparks were produced, just as previously in the secondary conductor itself; but in the enclosed conductor not the slightest electrical movement could be recognised. The result of the experiment is not affected if the envelope touches the conductor at a few points; the insulation of the two from each other is not necessary in order to make the experiment succeed, but only to give it the force of a proof. Clearly we can imagine the envelope to be drawn more closely round the conductor than is possible in the experiment; indeed, we can make it coincide with the outermost layer of the conductor. Although, then, the electrical disturbances on the surface of our conductor are so powerful that they give sparks 5 to 6 millimetres long, yet at $\frac{1}{20}$ millimetre beneath the surface there exists such perfect freedom from disturbance that it is not possible to obtain the smallest sparks. We are brought, therefore, to the conclusion that what we call an induced current in the secondary conductor is a phenomenon which is manifested in its neighbourhood but to which its interior scarcely contributes.

2. One might grant that this is the state of affairs when the electric disturbance is conveyed through a dielectric, but maintain that it is another thing if the disturbance, as one usually says, has been propagated in a conductor. Let us place near one of the end plates of our primary conductor a conducting-plate, and fasten to it a long, straight wire; we have already seen in the previous experiments how the effect of the primary oscillation can be conveyed to great distances by the help of this wire. The usual theory is that a wave travels along the wire in this case. But we shall try to show that all the alterations are confined to the space outside and the surface of the wire, and that its interior knows nothing of the wave passing over it. I arranged experiments first of all in the following manner:—A piece about 4 metres long was removed from the wire conductor and replaced by two strips of zinc plate 4 metres long and 10 centimetres broad, which were laid flat one above the other, with their ends permanently connected together. Between the strips along their middle line, and therefore almost entirely surrounded by their metal was laid along the whole 4 metres length a copper wire covered with gutta-percha. It was immaterial for the experiments whether the outer ends of this wire were in metallic connection with, or insulated from, the strips; however, the ends were mostly soldered to the zinc strips. The copper wire was cut through in the middle, and its ends were carried, twisted round each other, outside the space between the strips to a fine spark-gap, which permitted the detection of any electrical disturbance taking place in the wire. When waves of the greatest possible intensity were sent through the whole arrangement there was nevertheless not the slightest effect observable in the spark-gap. But if the copper wire was then displaced anywhere a few decimetres from its position, so that it projected just a little beyond the space between the strips, sparks immediately began to pass. The sparks were the more intense according to the length of copper wire extending beyond the edge of the zinc strips and the distance it projected. The unfavourable relation of the resistances was therefore not the cause of the previous absence of sparking, for this relation has not been changed; but the wire being in the interior of the conducting mass was at first deprived of the influence coming from without. Moreover, it is only necessary for us to surround the projecting part of the wire with a little tinfoil in metallic communication with the zinc strips, in order to immediately stop the sparking again. By this means we have brought the copper wire back again into the interior of the conductor. If we bend another wire into a fairly large arc round the projecting portion of the gutta-percha wire, the sparks will be likewise weakened; the second wire takes off from the first a certain amount of the effect due to the outer medium. Indeed, it may be said that the edge of the zinc strip itself takes away the induction from the middle of the strip in a similar manner. For if we now remove one of the strips, and leave the insulated wire simply resting on the other one, we certainly obtain sparks continuously in the wire; but they are extremely weak if the wire lies along the middle of the strip, and much stronger when near its edge. Just as in the case of distribution under electrostatic influence the electricity would prefer to collect on the sharp edge of the strip, so also here the current tends to move along the edge. Here, as there, it may be said that the outermost parts screen the interior from outside influence.

The following experiments are somewhat neater and equally convincing. I inserted into the conductor transmitting the waves a very thick copper wire, 1·5 metre long, whose ends carried two circular metallic disks of 15 centimetres diameter. The wire passed through the centres of the disks; the planes of the disks were at right angles to the wire; each of them had on its rim 24 holes, at equal distances apart. A spark-gap was inserted in the wire. When the waves traversed the wire they gave rise to sparks as much as 6 millimetres long. A thin copper wire was then stretched across between two corresponding holes of the disks. On doing this, the length of the sparks sank to 3·2 millimetres. There was no further alteration if a thick copper wire was put in the place of the thin one, or if, instead of the single thin wire, twenty-four of them were taken, provided they were placed near each other through the same two holes. But it was otherwise if the wires were distributed over the rim of the disks. If a second wire was inserted opposite the first one, the spark-length fell to 1·2 millimetres. When two more wires were added midway between the first two, the length of the spark sank to 0·5 millimetres; the insertion of four more wires still in the mean positions left sparks of scarcely 0·1 millimetres long; and after inserting all the twenty-four wires at equal distances apart, not a trace of sparking was perceptible in the interior. The resistance of the inner wire was never-

* Lodge, *Journ.* Soc. Arts (May, 1888); *Phil. Mag.* [5], XXVI., p. 217 (1888).

† Hertz, Wied. *Ann.*, XXXIV., p. 551 (1888).

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theless much smaller than that of all the outside wires taken together; we have also a still further proof that the effect does not depend upon this resistance. If we place by the side of the partial tube of wires, and in parallel circuit with them, a conductor in all respects similar to that in the interior of the tube, we have in the former brilliant sparks, but none whatever in the latter. The former is unprotected, the latter is screened by the tube of wires. We have in this an electrodynamic analogue of the electrostatic experiment known as the electric birdcage. I again altered the experiment, in the manner depicted in Fig. 1. The two disks were placed so near together that they formed, with the wires inserted between them, a cage (A) just large enough for the reception of the spark-micrometer. One of the disks, α, remained metallically connected with the central wire; the other, β, was insulated from the wire by means of a circular hole through its centre, at which it was connected to a conducting-tube, γ, which, insulated from the central wire, surrounded it completely for a length of 1·5 metre. The free end of the tube, δ, was then connected with the central wire. The wire, together with its spark-gap, is once more situated in a metallically protected space; and it was only to be expected, from the previous experiments, that not the slightest electrical disturbance would be detected in the wire in whichever direction waves were sent through the apparatus. So far, then, this arrangement promises nothing new, but it has the advantage over the previous one that we can replace the protecting metallic tube, γ, by tubes of smaller and smaller thickness of wall, in order to investigate what thickness is still sufficient to screen off the outside influence. Very thin brass tubes, tubes of tinfoil and Dutch metal proved to be perfect screens. I now took glass tubes which had been silvered by a chemical method, and it was then perfectly easy to insert tubes of such thinness that, in spite of their protecting power, brilliant sparks occurred in the central wire. But sparks were only observed when the silver film was no longer quite opaque to light and was certainly thinner than $\frac{1}{100}$ millimetre. In imagination, although not in reality, we can conceive the film drawn closer and closer round the wire, and finally coinciding with its surface; we should be quite certain that nothing would be radically altered thereby. However actively, then, the real waves play round the wire its interior remains completely at rest; and the effect of the waves hardly penetrates any more deeply

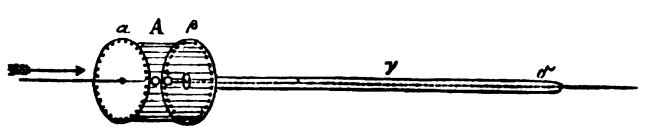

FIG. 1.

into the interior of the wire than does the light which is reflected from its surface. For the real seat of these waves we ought not to look, therefore, in the wire, but rather to assume that they take place in its neighbourhood; and instead of asserting that our waves are propagated in the wire, we should be more accurate in saying that they glide along on the wire.

Instead of placing the apparatus just described in the circuit in which we introduced waves indirectly, we can insert it in one branch of the primary conductor itself. In such experiments I obtained results similar to the previous ones. Our primary oscillation, therefore, takes place without any participation of the conductor in which it is excited, except at its bounding surface; and we ought not to look for its existence in the interior of the conductor.*

To what has been said above about waves in wires we wish to add just one remark concerning the method of carrying out the experiments. If our waves have their seat in the neighbourhood of the wire, the wave progressing along a single isolated wire will not be propagated through the air alone; but since its effect extends to a great distance it will partly be transmitted by the walls, the ground, &c., and will thus give rise to a complicated phenomenon. But if we place opposite each pole of our primary conductor in exactly the same way two auxiliary plates, and attach a wire to each of them, carrying the wires straight and parallel to each other to equal distances, the effect of the waves makes itself felt only in the region of space between the two wires. The wave progresses solely in the space between the wires. We can thus take precautions to propagate the effect through the air alone or through another insulator, and the experiments will be more convenient and free from error by this arrangement. For the rest, the lengths of the waves are nearly the same in this case as in isolated wires, so that with the latter the effect of the disturbing causes is apparently not considerable.

* The calculation of the self-induction of such conductors on the assumption of uniform density of current in their interior must therefore lead to quite erroneous results. It is to be wondered at that the results obtained with such wrong assumptions should still appear to approximately coincide with truth.

3. We can conclude from the above results that rapid electric oscillations are quite unable to penetrate metallic sheets of any thickness, and that it is, therefore, impossible by any means to excite sparks by the aid of such oscillations in the interior of closed metallic screens. If, then, we see sparks produced by such oscillations in the interior of metallic conductors, which are nearly, but not quite, closed, we shall be obliged to conclude that the electric disturbance has forced itself in through the existing openings. This view is also correct, but it contradicts the usual theory in some cases so completely that one is only induced by special experiments to give up the old theory in favour of the new one. We shall choose a prominent case of this kind, and by assuring ourselves of the truth of our theory in this case, we shall demonstrate its probability in all other cases. We again take the arrangement which we have described in the previous section and drawn in Fig. 1; only we now leave the protecting tube insulated from the central wire at δ. Let us now send a series of waves through the apparatus in the direction from A towards δ. We thus obtain brilliant sparks at A; they are of similar intensity to those obtained when the wire was inserted without any screen. The sparks do not become materially smaller, if, without making any other alteration, we lengthen the tube γ considerably, even to 4 metres. According to the usual theory it would be said that the wave arriving at A penetrates easily the thin, good-conducting metal disc α, then it leaps across the spark-gap at A, and travels on in the central wire. According to our view, on the contrary, we must explain the phenomenon in the following manner:—The wave arriving at A is quite unable to penetrate the metallic disc; it therefore glides along the disc over the outside of the apparatus and travels as far as the point δ, 4 metres away. Here it divides: one part, which does not concern us at present, travels on immediately along the straight wire, another bends into the interior of the tube and then runs back in the space between the tube and the central wire to the spark-gap at A, where it now gives rise to the sparking. That our view, although more complicated, is still the correct one, is proved by the following experiments:—Firstly, every trace of sparking at A disappears as soon as we close the opening at δ, even if it be only by a stopper of tinfoil. Our waves have only a wavelength of 3 metres; before their effect has reached the point

FIG. 2.

δ the effect at A has passed through zero and changed sign. What influence, then, could the closing of the distant end δ have upon the spark at A, if the latter really happened immediately after the passage of the wave through the metallic wall? Secondly, the sparks disappear if we make the central wire terminate inside the tube γ, or at the opening δ itself; but they reappear when we allow the end of the wire to project even 20 to 30 centimetres only beyond the opening. What influence could this insignificant lengthening of the wire have upon the sparks in A, unless the projecting end were just the means by which a part of the wave breaks off and penetrates through the opening δ back into the interior? Thirdly, we insert in the central wire between A and δ a second spark-gap B, which we also completely cover with a gauze cage like that at A. If we make the distance of the terminals at B so great that sparks can no longer pass across, it is also no longer possible to obtain visible sparks at A. But if we hinder in like manner the passage of the spark at A, this has scarcely any influence on the sparks in B. Therefore the passage of the spark at B determines that at A, but the passage of a spark at A does not determine that at B. The direction of propagation in the interior is therefore from B towards A, not from A to B.

We can moreover give further proofs, which are more convincing. We may prevent the wave returning from δ to A from dissipating its energy in sparks, by making the spark-gap either vanishingly small or very great. In this case the wave will be reflected at A, and will now return again from A towards δ. In doing so, it must meet the direct waves from δ to A and combine with them to form stationary waves, thus giving rise to nodes and ventral segments. If we succeed in proving their existence, there will be no longer any doubt as to the truth of our theory. For this proof we must give somewhat different dimensions to our apparatus in order to be able to introduce electric resonators into its interior. I therefore led the central wire though the axis of a cylindrical tube 5 metres long and 30 centimetres diameter. It was not constructed of solid metal, but of 24 wires arranged parallel to each other along the generating surface, and resting on seven equidistant and circular rings of strong wire, as shown in Fig. 2. I made the requisite resonator in the following manner:—A closely-

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wound spiral of 1 centimetre diameter was formed from copper wire 1 millimetre thickness; about 125 turns of this spiral were taken, drawn out a little, and bent into a circle of 12 centimetres diameter: between the free ends an adjustable spark-gap was inserted. Previous experiments had shown that this circle responded to waves 3 metres long in the wire, and yet it was small enough in size to admit of its insertion between the central wire and the surface of the tube. If now both ends of the tube were open, and the resonator was then held in the interior in such a way that its plane included the central wire, and its spark-gap was not directed exactly inwards or outwards, but was turned towards one end or the other of the tube, brilliant sparks of $\frac{1}{2}$ to 1 millimetre length were observed. On now closing both ends of the tube by four wires arranged crosswise and connected with the central conductor, not the slightest sparking remained in the interior, a proof that the network of the tube is a sufficiently good screen for our experiments. The end of the tube on the side β, that, namely, which was furthest away from the origin of the waves, was now removed. In the immediate neighbourhood of the closed end, that is at the point a, which corresponds to the spark A of our previous experiments, there were now no sparks observable in the resonator. But on moving away from this position towards β, sparks appeared, became very brilliant at a distance of 1·5 metre from a, then decreased again in intensity, they almost entirely vanished at 3 metres distance from a, and increased again until the end of the tube was reached. We thus find our theory borne out by fact. That we obtain a node at the closed end is clear, for at the metallic contact between the central wire and the surface of the tube the electric force between the two must necessarily vanish. It is different when we cut the central conductor at this point just near the end, and insert a gap of several centimetres length. In this case the wave will be reflected in a phase opposite to that of the previous case, and we should expect a ventral segment at a. As a matter of fact we find brilliant sparks in the resonator in this case; and they rapidly decrease in strength if we move from a towards β, they almost entirely vanish at a distance of 1·5 metre, and become brilliant again at a distance of 3 metres; moreover they give a second well-marked node at 4·5 metres distance, that is 0·5 metre from the open end. The nodes and loops which we have described are situated at fixed distances from the closed end, and alter only with this distance; they are, however, quite independent of the occurrences outside the tube, for example, of the nodes and loops formed there. The phenomena occur in exactly the same way if we allow the wave to travel through the apparatus in the direction from the open to the closed end; their interest is, however, smaller, since the mode of transmission of the wave deviates from that usually conceived, less in this case than in the one which has just been under our consideration. If both ends of the tube are left open with the central wire undivided, and stationary waves with nodes and loops are now set up in the whole system, there is always found, for every node outside the tube, a corresponding node in the interior; which proves that the propagation takes place inside and outside with, at any rate approximately, the same velocity.

On looking over the experiments which we have described, and the interpretation put upon them, as well as the explanations of the physicists referred to in the introduction, a difference will be noticed between the views here put forward and the usual theory. According to the latter, conductors are represented as those bodies which alone take part in the propagation of electric disturbances; non-conductors are the bodies which oppose this propagation. According to our view, on the contrary, all transmissions of electrical disturbances is brought about by non-conductors; conductors oppose a great resistance to any rapid changes in this transmission. One might almost be inclined to maintain that conductors and non-conductors should, on this theory, have their names interchanged. However, such a paradox only arises because one does not specify the kind of conduction or non-conduction considered. Undoubtedly metals are non-conductors of electric force, and just for this reason they compel it under certain circumstances to remain concentrated instead of becoming dissipated, and thus they become conductors of the apparent source of these forces, electricity, to which the usual terminology has reference.

Karlsruhe, March, 1889.

ELECTRICAL STANDARDS.*

As a general rule, the most convenient method of obtaining the absolute value of any magnitude is to compare it with a *standard*—that is to say, with a magnitude of a similar kind whose value is unity or some known multiple of unity. Therefore, in precise measurements, the choice of standards and the determination of them in absolute values has a very great interest attaching to it. It is easy to see how a conductor standardised at a constant temperature can furnish a standard resistance, how a condenser of known capacity can furnish a standard capacity; but there are magnitudes, such as the strength of a current or a quantity of electricity, of which it is difficult to have true standards. In these cases the difficulty is got over by having instruments which always give the same indication when traversed by currents of the same strength, and these instruments, which serve the purpose of a true standard, deserve the name of *standard instruments*.

In electro-magnetic measurements (the only ones with which we need concern ourselves here) there are only three magnitudes of which the values in absolute units can be obtained directly; these are:—

1. The coefficients of mutual induction or of self-induction, of which the value can be obtained by simple measures of length (dimensions [L]).

2. The resistance of a conductor, the value of which can be given by measures of length and of time (dimensions $[L T^{-1}]$).

3. The strength of a current, the value of which can be given by the measure of a force and by measurements connected with length (dimensions $[F^{\frac{1}{2}}] = [L^{\frac{1}{2}} M^{\frac{1}{2}} T^{-1}]$).

Also the standards of these three magnitudes are suitably called the *primary standards*, for these are the only ones whose values can be easily ascertained without having recourse to other electrical standards. On the other hand, the standards of the other electrical magnitudes, which, in practice, reduce to the standards of electromotive force and capacity, will be called *derived standards*.

Primary Standards.

1. *Standards for Coefficients of Mutual Induction and of Self-Induction.*—We will confine ourselves to remarking that it would be useful to have standards for coefficients of mutual induction. Such standards do not yet exist, or, at least, are not common in laboratories.

2. *Standard Resistances.*—In 1882 the International Conference on Electrical Units in its first session decided that a standard resistance having the value of an ohm should be constructed, and invited the assistance of the *savants* of the different countries represented at the Conference in order to decide what length should be given to column of mercury at 0°C., having one millimetre square section, in order that it should represent the theoretical ohm (10^9 C.-G.-S. units). In its second session, in 1884, after having reviewed the work done on this subject,* it fixed the length at 106 centimetres. The legal ohm *is the resistance of a column of mercury having a sectional area of one square millimetre and a length of* 106 *centimetres at the temperature of melting ice.*

M. Benoît, at the International Bureau of Weights and Measures, has constructed in mercury, for the Minister of Posts and Telegraphs, four model standards, representing the legal ohm.† Each of these standards consists of a rectilineal glass tube, having a sectional area of about one square millimetre, whose ends open into large containing vases, which, together with the tube, are filled with very pure mercury. The whole rests on a brass base, which allows the apparatus to be plunged in melting ice or of its being put into a bath at a known temperature. The glass tube has been calibrated, and gauged with all attainable accuracy, and cut to such a length that the standard shall represent the legal ohm, due allowance being made in construction for the correction in length necessary owing to the spreading out of the lines of force in the mercury of the vases. In addition, M. Benoît has constructed, for the Minister of Posts and Telegraphs, a great number of secondary standards, formed of a glass tube, five times bent back on itself in vertical bends, and terminated by two large tubes forming funnels, which, together with the narrow tube, are full of mercury. The resistance of these secondary standards has been obtained by electrical comparison with the model standards. These secondary standards have served to calibrate the metallic resistances of the French makers.

They proceeded differently in England. The specific resistance of mercury had been determined as a function of the ohm of the British Association by many physicists, amongst others by Lord Rayleigh and Mrs. Sidgwick.‡

Following this determination the Committee of the British Association has taken

1 legal ohm = 1·0112 B.A.U.

The English legal ohm has a slightly higher resistance than the French; the difference is $0{\cdot}0005\omega$, taking the figures given by Mr. R. T. Glazebrook.§

In a recent work on the specific resistance of mercury, Messrs. Glazebrook and Fitzpatrick‖ have compared the original standard ohms of the British Association¶ with the resistance at 0°C. of a column of mercury one metre in length, and whose sectional area was one square millimetre. They find that the resistance of this column of mercury is 0·95352 B.A.U., and consequently

1 legal ohm = 1·0107 B.A.U.

Taking this result, the English legal ohm is too great by $0{\cdot}0005\omega$, and the French legal ohm is accurate.

* Report presented to the Paris International Electrical Congress, 1889, by M. Pellat.

* "Procés-verbaux de la Conférence internationale pour la determination des unités électriques," p. 43.

† "Construction des étalons prototypes de résistance électrique du Ministère des Postes et Télégraphes," par René Benoît. (Gauthier-Villars, 1885.)

‡ "On the Specific Resistance of Mercury," *Chemical News*, No. 1,172, May, 1882; *Phil. Trans.*, Part I. (1883).

§ "A Comparison of the Standard Resistance Coil, &c.," *Phil. Mag.*, Fifth Series, Vol. XX., p. 343 (1885).

‖ "On the Specific Resistance of Mercury," *Phil. Trans.*, Vol. CLXXIX. (1888).

¶ These standards, to the number of eight, are deposited in the Cavendish Laboratory, Cambridge.

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The standard resistances of Messrs Siemens and Halske,* which have been constructed to represent the resistance at 0°C. of a column of mercury one metre long and one square millimetre sectional area, have served the German makers as a basis for obtaining the legal ohm ; they have taken

1 legal ohm = 1·06 Siemens' unit.

Siemens and Halske's standard has been subjected to several comparisons with the mercury standards of different experimenters ; the results are as follows :—

Experimenters.		
1882.....	Lord Rayleigh and Mrs. Sidgwick.....	0·99949†
1884.....	Roïti	0·99997†
1884.....	Mascart, de Nerville and Benoit	1·00003†
1884.....	Strecker (mean of two Siemens' standards)	1·00017†

From this table we see that Messrs. Siemens and Halske's standards agree well with the other mercurial standards if we take into account the slight error in the experiments of Lord Rayleigh and Mrs. Sidgwick which seems to exist if we follow the work of Messrs. Glazebrook and Fitzpatrick, and which would nearly bring the first numbers given in the table up to unity.

The mean of the numbers presented to the 1884 Conference as the length of the column of mercury representing the true ohm is 106·04. The mean of the numbers obtained by the method of lowering the current strength gives a mean decidedly lower than that furnished by the other methods. M. Mascart‡ has since shown that this method requires several corrections which have not been made, and which tend to raise the number. Suppressing the numbers due to the method of lowering the current strength, the mean rises to 106·15. A discussion of the methods employed still further raises the number, and would bring it up to 106·25.

Since 1884 a fairly large number of other determinations of the ohm are nearly all in agreement in furnishing numbers close to 106·30 (the number brought to the Conference in 1884 by MM. Mascart, de Nerville and Benoît ; by Mr. Glazebrook and Lord Rayleigh, 106·28). Amongst these experiments we ought to mention those of Prof. Rowland,§ made under most favourable conditions, and which give the figure 106·32 ; the experiments of F. Kohlrausch‖ (106·32), and the quite recent ones of M. Dorn¶ (106·24) made by the method of lowering the current and corrected ; the experiments of M. Wuilleumier** (106·27) made by the excellent modification of Lorenz's method suggested by M. Lippmann.

To sum up, these different measurements agree in showing that in taking 106·30 as the length of the column of mercury representing the theoretical ohm there is probably only an error of less than $\frac{1}{3000}$.

3. *Standards for Current Strength.*—As a general rule, the absolute value of the strength of an electrical current is measured by one of the three following methods :—1. The tangent galvanometer method ; 2. Kohlrausch's method ; 3. The electro-dynamometer methods, and principally by electro-dynamometer balances. These latter instruments give the current strength by weighing it, using the formula $i = A\sqrt{pg}$, where p is the number of grammes in the weight (pg) which balances the electro-dynamic force, and A is a constant depending on the form of the instrument and determined by measures of lengths ; these latter may be made by an arbitrary unit, since it only enters into the expression A in the ratio of the lengths. The electro-dynamometer balances thus come into the category of standard instruments. On account of the simplicity of measurement with these instruments a greater accuracy can be obtained than with other methods.

MM. Joule, Cazin, Mascart, Helmholtz, &c., have constructed balances for the purposes of special researches ; each of these instruments seems capable of serving as an original model standard, but no copy has been made. There are, however, standard instruments giving the absolute value of the current strength. Sir W. Thomson is the inventor of a series of electrical balances, designed, some to measure weak currents (milli-ampere, centi-ampere), others to measure currents of a deci-ampere or an ampere ; others, again, for currents of a hundred amperes up to a thousand amperes. These instruments are widely distributed in England and in some other countries.

In France M. Pellat†† has had constructed by M. Carpentier an electro-dynamometer-balance which differs from those employed till then in that the small coil with vertical axis is in one with the beam of the balance and is placed in the centre of a long horizontal coil. The small coil having only one turn of wire, and being far from the ends of the large coil, the irregularities of winding which always occur at the ends of a coil of many turns of wire are here without effect. The necessary measures of length required to determine the constant A were made, through the courtesy of the International Bureau of Weights and Measures. Taking all the possible errors in the measurements and adding them together we find that the error made in the constant A cannot exceed $\frac{1}{3000}$. Moreover, the error due to the weights is very trifling.

Further, M. Pellat* has had constructed by M. Carpentier copies of his absolute electrical balance, to which he has given the name of standard ampere balance ; they only differ from the former instrument in that the moving coil has several turns of wire and the fixed coil is much shorter. The constant A of the standard ampere balance was determined by comparison with the absolute electro-dynamometer ; this determination was made with an accuracy of $\frac{1}{10000}$. The constant A is absolutely independent of temperature.

Derived Standards.

1. *Standards of Electromotive Force.*—A cell furnishes a standard of electromotive force. The absolute value of the difference of potential between the two terminals of the cell on open circuit, which is the measure of its electromotive force, is determined by comparing it with the difference of potential e which exists at the ends of a known resistance traversed by a known current i ($e = ir$). The comparison may be made either by charging a condenser, or, which is much more accurate, by opposing the cell and the electromotive force developed at the ends of the resistance by the passage of the current, and varying this until the two electromotive forces are equal. Unfortunately no cell studied by the exact method above described possesses an electromotive force which does not vary in time.

The cells which are most employed as standards are the copper-sulphate Daniell, or its different modifications (Callaud's, the Post Office standard, &c.), the Latimer Clark sulphate of mercury cell, and Gouy's cell with bionxide of mercury. Unless very great precautions are taken in its setting up and in its maintenance,† the Daniell is useless as a standard where great accuracy is required. The electromotive force of cells of the same construction but with elements from different sources may vary from 1·06 volt to 1·14 volt at least. And more serious still, the inevitable changes taking place on the surfaces of the metal electrodes prevent the electromotive force remaining constant when the cell is set up. The best way of having a Daniell whose electromotive force shall be nearly constant is to set it up with new solutions before using it, and close the circuit for some time so as to coat the copper electrode with copper ; the cell should then be left on open circuit for some minutes before using it as a standard.

The Latimer Clark and the Gouy, in which pure amalgamated zinc and mercury are used as electrodes, are far preferable. The metals do not alter, or, at least, the alteration which takes place in lapse of time on the surface of the zinc does not affect the electromotive force. The Latimer Clark may be constructed in one of two different ways : (1) by using as an electrolyte a paste formed of mercurous sulphate soaked in a solution of zinc sulphate; (2) by employing a weak (say 15 per cent.) solution of sulphate of zinc and spreading the mercurous sulphate in a powder on the surface of the mercury.‡ According to the unpublished work of Messrs. Potier and Pellat, the liquid Latimer Clark (1·466 volt mean) is preferable to the Latimer Clark with a pasty electrolyte. The electromotive force varies less with time ; the coefficient of variation for temperature is about half that of the other, and its temperature can be known accurately, which is impossible with a pasty electrolyte. Fiually the cell is a better conductor and polarises very little on the passage of the current.

Several liquid Latimer Clark's, constructed almost at the same time, do not differ as a rule by more than $\frac{1}{1000}$ from their mean value at the same temperature, unless by some accident the mercury has touched the zinc ; traces of zinc in the mercury are sufficient to diminish the electromotive force considerably ; it may even be annulled or reversed. The Gouy cell§ (1·390 mean voltage) is as remarkable for its constancy as the Latimer Clark ; it only differs from the liquid Latimer Clark by the substitution of oxide of mercury for mercurous sulphate in the electrolyte. This alteration has an advantage and a disadvantage ; the advantage is that the variation of the electromotive force for change of temperature is reduced to nearly one-half (0·0014 about) ; the inconvenience is that the depolariser is less efficacious, and therefore the polarisation of the Gouy cell is much greater and takes longer to disappear than in the case of the liquid Latimer Clark.

Different Gouy cells prepared with substances from the same source do not differ as a rule by more than $\frac{1}{100}$ from their mean value.

To sum up, either the Latimer Clark or the Gouy cell might be of great use, even in researches requiring the greatest accuracy ; but for this we must have a thermometer with its bulb plunged in the electrolyte to give the temperature of the cell. We ought besides from time to time to measure the absolute value of the electromotive force of the standard, and to compare its value frequently with similar standards placed under similar conditions as to temperature in order to be sure that the electromotive force has not varied by a sensible amount owing to some accident.

One of the principal uses of a standard of electromotive force whose absolute value is known is to measure quickly and accurately a weak or strong current by the opposition of this standard to the electromotive force set up by it at the two ends of some suitable known resistance—by reversing the operation, in fact, which served to determine the absolute value of the cell. Together these two operations constitute the most simple and exact

* The mercury standards of M. Siemens were first constructed in 1868. In 1881 to 1882, the old standards having nearly all disappeared by a series of accidents, a very careful reconstruction of mercurial standards was made with rectilineal glass tubes, gauged and calibrated by the Imperial Commission of Weights and Measures at Berlin. It is these new standards which are referred to above.

† Value of the Siemens' unit in terms of the resistance at 0°C. of a column of mercury one metre long and one square millimetre section.

‡ *Journ. de Phys.*, 2e série, t. IV., p. 101 (1885.)

§ Experiments published before the Manchester Meeting of the B.A. (1887).

‖ *Abhandl der k. bayer. Akad. der Wisseuch*, II. Classe, Vol. XVI.

¶ Académie des Sciences de Berlin, July 5, 1888.

** *Comptes Rendus* de l'Académie des Sciences, June 4, 1888.

†† *Comptes Rendus* de l'Académie des Sciences, 13th December, 1866 ; *Journ. de Phys.*, 2e Série, t. VI., p. 175.

* *Bulletin de la Soc. Internat. des Electriciens*, t. V. (May, 1888).

† On this subject *vide* J. A. Fleming: "On the Use of Daniell's Cell as a Standard of Electromotive Force" (*Phil. Mag.*, August, 1885). In spite of the opposite conclusion of the author the very careful work of J. A. Fleming shows that it is very difficult to get a good standard of electromotive force from the Daniell.

‡ "Instead of spreading the mercurous sulphate it may be formed by the electrolysis of the sulphate of zinc in the cell itself by causing a current to flow through it from the mercury to the zinc." (Unpublished work of M. Potier.)

§ Gouy, "Sur une pile étalon," *Journ. de Phys.*, 2e série, t. VI., p. 532.

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method of comparing the value of a known current (taken on electric dynamometer balance) with the value of a current of very different strength.

2. *Standards of Capacity.*—The standards of capacity are condensers graduated in microfarads and fractions of a microfarad; they are made of tinfoil, or sometimes tinsel, alternating with some insulating substance. This insulating substance varies with the makers; those substances most often employed being mica, paraffined mica, paper paraffined or covered with some other insulating material, finally ebonite cut down into very thin leaves. The standards of capacity are still much more imperfect than the standards of electromotive force. These all show three great faults in a greater or less degree: (1) The charge is not rigorously proportional to the difference of potential of the plates; (2) they have a residual charge; (3) the insulation is imperfect. Moreover, the capacity varies fairly rapidly with the temperature.

When a condenser has a residual charge, its capacity is only strictly accurate in two cases—that in which discharge follows charge so rapidly that there is no penetration of the electricity into the dielectric, and that in which the charge lasts sufficiently long for the penetration to have attained its maximum. But when using condensers it is often difficult to realise these conditions. As an instance, if we wish to measure the charge on a condenser by discharging it through a galvanometer and noting the swing of the needle we make use of a formula which is only exact if the discharge takes place in so short a time that the needle has not moved sensibly while it lasts; now this does not happen if the penetration has attained its maximum, since the total discharge requires a time comparable to that of charge.

An air condenser is the only condenser which could be considered a true standard. Unfortunately it would appear difficult to obtain an air condenser of a capacity of about a microfarad of a convenient size, since two circular plates 60 centimetres in diameter and distance apart 0·025 centimetre form a condenser of about $\frac{1}{100}$ microfarad capacity.

The determination of the absolute value in electro-magnetic units of a capacity is made most often by methods in which the capacity is referred to that of a resistance and a time, as in Maxwell's method,* or its modifications by J. J. Thompson† and R. T. Glazebrook‡; or, better, by the methods in which the measure of the capacity is referred to that of a resistance and a coefficient of mutual induction, such as that employed by M. Roïti in the study of the different condensers displayed at the Antwerp§ Universal Exhibition.

The measures of M. Roïti and of other physicists show that the real value of the capacities found in commerce rarely differ by less than 1 per cent. from their nominal value, and that often the error rises to 4 per cent.

In concluding this report on electrical standards, we may be allowed to express a wish.

The standards of mutual induction, of resistance, and of current strength, which we have called the *primary standards*, because their absolute value can be separately determined without having recourse to other electrical standards, show when suitably made an invariability similar to that of a standard of length or of mass.

The necessity of establishing a legal standard of resistance has been recognised, why should the same not apply to the other two principal standards?

The question is of especial importance in connection with current strength, and would seem now to be sufficiently matured. The International Bureau of Weights and Measures possesses already original standards of length, mass, and electrical resistance; it seems quite designed to take charge of an electro-dynamometer balance, which should serve as a model standard instrument for the measure of current strengths, and by it other instruments could be standardised.

Currents measured by the model electro-dynamometer by the formula $i = A\sqrt{p\,g}$, where A represents the constant of the instrument determined by measures of length, would give the value of a conventional ampere, which would only differ from the theoretical ampere by a quantity which would certainly be less than that by which the legal ohm differs from the true ohm; it is very probable the error would be less than $\frac{1}{2000}$. Moreover, we should have in M. Pellat's absolute electro-dynamometer a check on the readings of this instrument. Many people will think that for the purpose of comparing currents it would be more simple to take the mass of silver deposited in one second by an ampere. We must remark that the conventional ampere thus fixed would not be defined with sufficient precision; in fact, electrolysis is an extremely delicate operation, the sources of relative error in which are ten times greater than in the case of the comparison of two electro-dynamometer balances. Thus, the following are the last results obtained for the electrolytic equivalent of silver:—

	Mass of silver in milligrams deposited by 1 amp. in 1sec.
F. and W. Kohlrausch (‖)	1·1183 milligrams
Mascart (¶)	1·1156 „
Lord Rayleigh (**)	1·1179 „
MM. Potier and Pellat (††) { 1 determination	1·1189 } 1·1193 „
MM. Potier and Pellat (††) { 2 „ „	1·1195 }

Now, the differences which we find between the numbers on this table are not much greater than the same experimenter finds between the two electrolytic experiments made under as exactly similar conditions in all respects as possible. On the other hand, we have said higher up that the comparison between two electrical balances can be made with an accuracy of $\frac{1}{1000}$. This comparison shows clearly the inconvenience of a conventional ampere founded on electrolysis.

* "Electricity and Magnetism," § 776.
† *Phil. Trans.*, Vol. CLXXIV., p. 707 (June, 1883)
‡ *Phil. Mag.*, p. 98 (1884).
§ *Il Nuovo Cimento*, t. XVI. pp. 175—180.
(‖). *Sitz. des Phys. med. Ges. zu Wurtzburg* (1884).
(¶). *Journ. de Phys.*, 2e série, t. I., p. 100 (1882), et t. III., p. 283 (1884).
(**). *Phil. Trans.* of the R. S. L., Part II., p. 411 (1884).
(††). Soc. Franç. de Phys., March 15, 1889.

THE MEASURE OF ILLUMINATION.*

BY W. H. PREECE.

Photometry is the art of measuring the intensity of a source of light, such as an arc lamp, by direct comparison with some known source such as the carcel bec or British candle taken as unity; but the measure of the illumination of a surface, as far as intensity is concerned, is quite independent of the source of light itself, and it depends only on its distribution. The illumination of the page of the book we read, or of the paper on which we write, or the face which we address, or of the picture we admire, of the surface of the street on which we walk, varies in intensity whether the source of light which is distributed on these surfaces is the sun, the moon, or combustion, or incandescence of a carbon filament by currents of electricity, or whether it be single like daylight or multiplied like a well-planned electric light installation.

The standard that I propose is the intensity of illumination produced by a carcel lamp at a distance of one metre. This gives excellent illumination on the surface of a book. It is the same illumination as that given practically by a British candle at one foot distance, and thus it assimilates the English and French measures. I call this unit a "*LUX*," and I find that the illumination of the surface of a street lighted by a single ordinary gas burner is ·1 *lux*, while that due to an ordinary arc lamp is 1·8 *luces* if the measurement be made at the foot of the pole carrying the source of light.

In determining the illumination of the streets of a town I specify that the light shall be uniformly distributed over the surface of the street, and that the mean illumination shall not be less than three *lux*, and in the case of a room the light on any table in any part of the room should not be less than one *lux*, and this can be obtained by an expenditure of energy in glow-lamps in the ratio of about ten watts to one square metre floor surface. Hence a table of 100 square metres would take 1,000 watts, or 20 glow-lamps of 100 volts and five amperes or of 50 watts each well distributed to give a uniform illumination of about one *lux* on the level of the tables.

The measurement of this illumination is very simple. A small glow-lamp is placed inside a box, the top of which has a screen of white paper, on which is made a grease spot. The illumination of this grease spot on the inside is varied by varying the current incandescing the glow-lamp. The strength of this current is the measure of the light. The intensity of the current producing a *lux* is first determined in the laboratory, and then the illumination of any spot that it is desired to measure is afterwards found by measuring the amperes, which cause this grease spot to disappear at that point. A simple calculation based on the law that within limits the light given by an incandescent carbon filament varies as the 1^6 gives the *luces* directly from the current read on a simple, but delicate amperemeter.

* Paper read before the Paris Electrical Congress, 1889.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *August* 31, 1889.

The rise and fall of Mr. Harold P. Brown promises to be one of the most interesting and sensational episodes of late years in the electrical business in America. By this time your readers are probably pretty well acquainted with the doings of this gentleman, and will, therefore, not need a very long recital of his achievements. Some months ago Mr. Brown came to the front by writing letters to the daily papers attacking the alternating current, and particularly the Westinghouse apparatus. Previous to that time Mr. Brown had been engaged in various electrical pursuits, and had brought out one or two minor inventions, but did not in any way distinguish himself. When he began to write to the newspapers on the subject of the alternating current he had a great deal to say about the demerits of the Westinghouse apparatus, but as there was little else of the kind in the commercial field at that time this peculiarity did not attract much attention, it being taken for granted that the apparatus was spoken of as typical. A

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little bit later the question of electrical execution came to the front, and when discussion arose as to the manner in which it was to be administered, Mr. Brown advanced the proposition that the Westinghouse apparatus was just the thing for the purpose. It was at this juncture that people began to grow suspicious as to what Mr. Brown's motives were, because there was no special reason why any particular apparatus should be chosen or designated, it being easy enough for any competent electrical engineer to devise special alternating apparatus for the purpose without giving it any name, or without in any way injuring any company or system that might be upon the market. Thus the matter drifted along until all the experiments and discussions on the subject wound up with the actual purchase by Mr. Brown of Westinghouse alternating machines for the State, to be delivered at the various prisons where criminals under sentence of capital punishment were kept. Of course, it was not to be expected that the Westinghouse Company would sell its machines for any such purpose as this, and Mr. Brown had therefore to make his purchase in some underhand way. He did succeed, however, in getting the machines, and they were delivered to the prison authorities. In the meantime the renewed discussion of electrical execution and the appeal of the murderer Kemmler had led to an official investigation into the nature of death by electricity, and of the manner in which the electrical execution law had come to be adopted; and as I have recently recorded in my letters a vast amount of evidence was taken upon the subject. Of course, Mr. Brown was placed upon the stand. While there he bore himself with easy confidence, and stated that he was not in any way connected with any of the electric lighting companies. In other words, he was doing all this upon his own initiative from public-spirited motives. Mr. Bourke Cockran, who examined him, endeavoured to prove that he had had some pretty close connection with Mr. Edison, and had been engaged by the Edison Company to carry on this war against the alternating system. The effort, however, did not succeed very well, and those who thought that Mr. Brown had had some selfish purpose throughout, were left after all with only their conjectures. On Sunday last, however, the *New York Sun* lifted the veil of mystery, and revealed Mr. Harold P. Brown in a very striking and peculiar attitude. The *Sun* published on that day between forty and fifty letters exchanged by Mr. Brown with various companies and individuals in the electric business, and tending to show that Mr. Brown's interest throughout had been very much a pecuniary one. How the *Sun* got possession of these letters does not appear; but it is reasonable to infer that whoever got possession of them took them to the Westinghouse people, who in turn placed them at the disposal of the *Sun*, which has been very warm and strenuous from the first in its fight against the electrical execution law. These letters are written by Mr. Brown, Mr. Edison, Mr. A. E. Kennelly, Dr. Louis Duncan, of Johns Hopkin's University, and various officers of the Edison Company, the Thomson-Houston Company, and Frank Ridlon and Company, the latter concern being the one through which the secondhand Westinghouse apparatus was obtained. It is somewhat difficult to give a synopsis of this extraordinary correspondence, which covers so many points, but it may be stated that throughout Mr. Brown is shown in the position of asking for money or suggesting that money be paid to him, and actually receiving money for expert and other work from the State, from the Edison Company, and from the Thomson-Houston Company. In one of his letters he goes so far as to invite Mr. Edison to chip in to the extent of $5,000. But he does not appear to have obtained this amount, and thereupon, as far as can be discovered, ceases to have an interest in inviting the Edison people to "prick the Westinghouse bubble." Switching off from the Edison Company, he appears during the past summer to have devoted his energies to working up a connection with the Thomson-Houston Company, although upon just what grounds it does not clearly appear. He had already committed himself in favour of the use of the alternating current, and having carefully impressed the idea of the fatality of the alternating current on the public mind, considered that he was in a position to dictate terms to any company that had alternating-current apparatus, and that did not wish to have it used for execution purposes. Hence we find him writing to the Thomson-Houston Company upon two or three occasions that he was under tremendous pressure to use other than the Westinghouse apparatus, and that things might happen which would be very detrimental to the certain Boston interests. Anyhow, he did not fall back on the Thomson-Houston apparatus, but through Frank Ridlon and Company secured the Westinghouse apparatus that he was after, promising the Thomson-Houston Company that one of the sets thus secured, ostensibly for the State, should be sent to Johns Hopkins' University for testing as to efficiency by Dr. Louis Duncan, who does not seem to have had the slightest idea of the use to which he was being put. Mr. Brown appears to have tried to get the Thomson-Houston Company in the position of declaring that 1,000 volts alternating would be adequate for execution purposes, but the company in one of these letters come out in a flat-footed way, and say that they do not consider that such a current could be relied upon for extinguishing human life. I could touch upon a good many other points in this interesting and suggestive correspondence, but I think I have said enough to show Mr. Brown in the right light and in his true attitude. If I have not, it may suffice to add that in one of his letters he makes a statement, which has been contradicted, that he paid $275 for inserting his Westinghouse challenge in the New York newspapers, and that he planned, after the publication of his second challenge, to mail it to all electric lighting companies in the United States and Canada, and "to deluge any town with them where I learn the Westinghouse Company are trying to form a company." Such is the man, and such is the animus that have been allowed to dictate the choice of Westinghouse apparatus in this State for execution purposes. I need hardly say that after an exposure like this there is a very good chance of the public disgust leading to the repeal of the law, and even if it is not repealed, there is good reason to believe that the Westinghouse apparatus will not be employed for killing people by the State. There is a general sigh of relief in electrical circles at finding Mr. Brown thus shown up. People have not known what to make of him, or what to do with him, and he seems to have played his cards so cleverly as to have set various interests at loggerheads, and to have aroused and kept up animosities whose only result could be to benefit himself.

A great deal of interest is being taken at the present time in schemes for rapid transit. I do not mean ordinary railroad work with express trains, but systems which have lately been exploited which promise a speed of something like 80 or 100 miles an hour. Two of these have already been noted in these columns. One is the Portelectric system of Mr. Williams, in which the rapid transportation of parcels, mail matter, etc., is effected by sucking a carriage through a succession of helices mounted on a light elevated track. Another is the Weems' system, in which the inventor has a similar elevated track upon which he runs an electric car at a very high rate of speed, the armature of the motor driving directly upon the axles of the car. A short model of the Portelectric system has been exhibited in New York and Boston, and a track over one mile long is now to be erected at Dorchester, Mass., to show how it will work out in the open. This track will stand about six feet high, with numerous curves, grades, &c. The helices will be six feet apart, and the carriage 12 feet long, with a circular section of about 10 inches. The Weems' system, which has been tested on a short track near Baltimore, is said to have yielded a speed there of over two miles a minute, and is now to be brought near to New York and tested on a long experimental track on Long Island. Hence we shall soon know definitely about the real merits of these latest attempts to travel or send goods at a higher speed than the slow rate of 60 or 70 miles an hour, which is altogether too dilatory for America.

The application of electricity to the distribution of power is coming to the front in a remarkable manner, and one sees every day exemplifications of the manner in which electric motors are put to good use, showing their superiority over other machines. Some notable schemes are afloat for power distribution, and I have no doubt that a great many of them will be carried into effect. One of them proposes the installation of an electric-power plant in one of our large cities with the object of throwing out over 900

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steam engines, which average about 37 horse-power in capacity. Water is abundant, and it is proposed that the plant shall be built up from units of 1,000 horse-power compound condensing Corliss engines. A fair grade of coal is obtainable at $1.50 per ton, delivered, while fuel oil can be contracted for at $1.10 per hundred gallons. The longest circuit which would have to be installed would not exceed five miles. The majority of the owners of the steam plants readily admit that the introduction of the motor would effect a considerable saving in the operating expenses of their works and factories, and they are ready to adopt the motor in order to secure its conveniences. Hence it does not seem at all unlikely that at a very early day we may actually see a model central station power-plant of 40,000 horse-power capacity in full working order in the locality referred to. The great probability is that the load could be carried by a central station of much smaller capacity, but with a plant of 40,000 horse-power an immense amount of miscellaneous manufacture could be done, and manufacturers would be stimulated to increase their outputs to the fullest extent.

Another field in which we see a rapid introduction of the electric motor is that of mining, in which, I think, we are on the eve of great development in this country. It appears that Mr. Elmer A. Sperry, who has paid especial attention lately to the development of electric coal cutters, has met with excellent success. Some of his machines are now at work at Streeter, Ill., in a large coal mine on a circuit 8,000ft. long, and their working is so satisfactory that ten more machines are to be installed at the same place, while apparatus has also been ordered for Kewanee, Ill., Brazil, Ill., and Victoria, British Columbia.

Gas companies in various parts of the country are more and more finding a good practical utilisation of their gas in running gas machines to operate dynamos with. Several companies in the West are obtaining good results in this way. Thus, for example, at Iowa City, Iowa, a 20 horse-power Otto gas engine is running 16 arc lights on a three-mile street circuit, and the plant is to be increased. At Racihe, Wis., the gas company is running two Ottos, operating 62 Brush lamps of 2,000 candle-power on an 11-mile circuit. At Grand Forks, Dakota, the gas company is installing a 20 horse-power and a 50 horse-power Otto engine to run a plant of arcs and incandescents. The manufacturers of gas engines in this country are quick to perceive the opportunities that this work offers them, and are encouraging this kind of development as much as possible.

The news of work in the electric railway field is very encouraging, and now that the Fall approaches the companies are hustling to the full extent of their ability to get work done. As soon as the winter shuts in, stopping new work in the higher latitudes, we shall see greater activity than ever in the South, where scores of new electric railways are starting into existence. Just now every section alike is busy under the call for new equipments of every size. Electric roads are now to be found in all parts of the country, and even the weird territory of Utah is not to be excepted, as the Sprague Company has just put a fine road in operation in Salt Lake City. The company has started out with an initial equipment of 10 new Stephenson cars, and the tract is 4½ miles long, while 9 miles will be in operation by 1st September. The road is to be, when finished, 20 miles long, and to have at least 20 to 30 cars, which will be run in trains, so that when a Mormon family go to take a ride they can all go together.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *September* 8, 1889.

The Vienna-Prague Trunk line was completed on the 6th inst., and the first trials were made on Saturday last. The line is 310 kilometres long, and of silicium and phosphor bronze-wire, and runs quite alone. The result is that the line is entirely free from noise. It was begun on July 20, finished to outside Prague by August 20, and the town line was finished on the 6th. Speaking was perfect with the Gower-Bell microphone in Prague to a Berliner in Vienna on the direct metallic circuit ending in Prague and Vienna in the Post Office buildings. Then three translators were tried, and experiments were made from a subscribers' station in Prague to the Prague Exchange, through the Exchange to the Post Office, then through the translator over the metallic circuit line to Vienna. The Van Rysselburghe translator was first used, and the result was not very good ; then the Bennett was used, and speaking was as perfect as it could be, though not quite as loud as on the direct line ; last, a German translator, Landgraf, was used, and this one gave the best results, speaking being quite perfect in every way, and somewhat louder than with the Bennett translator. On Sunday the experiments were continued, at first between the two post offices on the direct line with the Gower-Bell, Berliner, and Schäffler microphones, all three working very well. Then a Landgraf translator was used in Vienna, the Post Office in Vienna being connected through the Vienna Exchange to a subscriber's office, and speaking to the Prague Post Office was tried. Speech was clear, but decidedly low. Then the Van Rysselburghe translator was tried and worked better, but not so well by a long way as the same experiment tried the day before from the Prague subscribers' station to Vienna Post Office with Landgraf and Bennett translators. After this, metallic circuit line from Prague Post Office to Vienna subscribers' station *via* Vienna Exchange was tried, speaking being again perfect. On this followed the experiment of speaking from Prague subscribers' station to Vienna subscribers' station *via* Prague Post Office and Exchange and Vienna Post Office and Exchange, Vienna subscribers being connected in metallic circuit ; Prague subscribers' station single line through Landgraf translator in Prague Post Office. Speaking was first-rate. Lastly, both subscribers' stations were connected through translators—in Prague, Landgraf, in Vienna, Van Rysselberghe—passing as before through both post offices and exchanges. Speaking was perfectly clear but not very loud. The Vienna lines being mostly cables, had, of course, an influence.

The experiments were on the whole a very decided success, and will be continued until perfect working is secured. The three apparatus used, Berliner, Schaffler, and Gower-Bell proved to be good instruments. It is expected that the line will be opened to the public in about a week or ten days.

An experiment was made speaking from the Prague Post Office *viâ* Vienna Post Office to Brünn, connected with Vienna by a telegraph line adapted on the Van Rysselberghe system. Speaking was fairly clear.

CORRESPONDENCE.

DISTRIBUTION BY MEANS OF CONDENSERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Being away on business I found on returning, in your issue of August 2nd, some remarks of Mr. J. D. F. Andrews upon my system of distribution.

Having been at work upon this matter for some six years, I have collected considerable experience in it.

Now, with respect to the statement of Mr. Andrews that currents of 5—8 amperes at 600—700 volts cannot be interrupted without violent sparking, I might add that this is indeed the case, but only so long as the number of reversals is not properly chosen, and I confess that this has been one of the chief inconveniences to overcome, which has caused me hard work for years.

What Mr. J. D. F. Andrews says about (his) Fig. 1 (*The Electrician*, August 2nd, p. 330) is quite true *per se*, but it has no bearing upon Fig. 3 in my article (*The Electrician*, July 26th, p. 294), for the latter represents the variation of the *current*, as can be seen from the text, whereas Mr. Andrews' diagram shows the charge (say in coulombs), which attains its maximum when the current is zero.

Concerning the arrangement which Mr. Andrews shows in his Fig. 3, it may be easily seen that the general effect would be increased, but the plant efficiency (economical coefficient) considerably lessened, by reason of the fact that always only a small part of the whole is made active.

Finally, Mr. Andrews speaks about the use of condensers for lighting glow-lamps in series. There was a time when I made numerous experiments in this direction with continuous as well as with alternating currents. But they have turned out unserviceable in practice, and so I have abandoned that way. Of course the current may be held invariable by short-circuiting the lamps ; but Mr. Andrews has overlooked another fact, namely, that the candle-power of the remaining lamps in-

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creases; and there would be only one way to keep the latter constant—that is, in decreasing the area of the condenser and consequently the current simultaneously with the number of burning lamps.—Yours, &c., DR. STEPHAN DOUBRAVA.

Brünn, Sept. 7, 1889.

AN IMPROVED LIGHTNING PROTECTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Bennet's logic is not good. He candidly tells us he knows nothing about the discarded bobbin protector of the Post-office; *he* does not agree with several of my concluding statements, which have nothing to do with the discarded bobbin protector; therefore my comparison of a portion of his invention—an improved lightning protector—with the said discarded bobbin protector must be worthless.

Here is Mr. Bennet's own description of the part of his protector which I likened to the old bobbin protector: ". . . consists of a coil of fine wire let into a rectangular slot in a *metal* earth-plate. The coil might with greater advantage be wound on a metal (non-magnetic) core, and be enclosed in a metal tube or box, and form part of, or be in contact with, the earth-plate." The discarded bobbin protector consisted of two fine insulated wires wound side by side around a brass cylinder, and encased in a brass tube. The tube and cylinder were joined electrically and to earth. Two wires were used, so that the protectors might do for terminal or intermediate stations. The modification of this protector, which is used in conjunction with a plain plate protector and a fine platinum wire on all Post-offices cable, so far as I am aware, has only one wire and is minus the outer tube.

I did not think it necessary in my last letter to describe the bobbin protector, as everybody who has any pretentions whatever to a knowledge of lighting protectors and their history knows the bobbin protector. It did good service in its day, the serious objection to it being that it broke down the circuit, and it has been entirely superseded for land lines by the plain plate protector with mica sheet. The Post Office electricians with a lengthened and varied experience have come to the conclusion that this plain plate protector is the most efficient. One of the objections to the serrated plate protectors I mentioned was that it had to be carefully protected from dust. Mr. Bennet says this is wholly imaginary. I do not think so, and I hardly think it is so imaginary as Mr. Bennet's suggest that some situations will be found too damp for the plain plate protector with mica sheet. I fancy if such a situation could be found the serrated protector would be of little avail. Damp dust, so far as I know, will conduct better than slightly damp mica. The dampest places in which protectors are used are the cable huts on the sea coast, and we have yet to learn that any hut has been found so damp as to impair the efficiency of the plain plate protector.

I might further mention that in *Journal* No. 71 of the Institute of Electrical Engineers there is an abstract on Lightning Discharges. The author of the Paper tested eight different protectors, including a serrated and a few plain plate protectors with the opposing surfaces at different distances. The conclusion which the experimenter arrived at was that the two metal plates with smooth surfaces one millimetre apart gave the most perfect protection.—Yours, &c.,

Aberdeen, 9th September, 1889. W. NOBLE.

BOOKS, &c., RECEIVED.

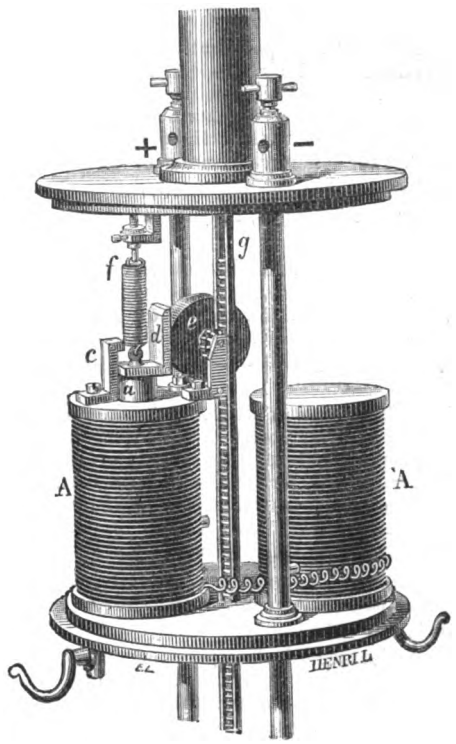
"Syllabus for the Twenty-second Session of the Leeds School of Science and Technology."

"The Steam Engine." A lecture by Edward N. Dickerson, LL.D., before the Electric Club of New York, January 17, 1889. (New York.)

Reduction of Telephone Subscriptions in France.—Consequent on the Government acquisition of the telephones the subscriptions are to be reduced from £24 to £16 in Paris, and from £16 to £12 and £8 in the provincial towns.

THE WENZEL ARC LAMP.*

The mechanism of the Wenzel lamp comprises a toothed rack, *g*, forming part of the positive carbon-holder and engaging with a small pinion, which is fixed to the iron drum *e*; a differential solenoid A, and a fine wire coil A', intended to increase the resistance of the shunt. The core *a* terminates in a square piece of metal, *d*, which rubs against the drum *e*, and it is held out of the solenoid by the spring *f*. A little catch *c* prevents *d* from rising beyond a certain point.



When the circuit is closed, the core *a* is sucked into the solenoid, and the head *d*, which is strongly magnetised, drags round the iron drum *e*, lifting the rack and striking the arc. When the length of the arc becomes excessive, the demagnetising effect of the shunt current allows the drum *e* to revolve, so that the positive carbon-holder descends. These movements are very regular and the lamp burns steadily.

THE E.M.F. DUE TO THE ACTION OF LIGHT ON SELENIUM.

In a recent number of Wiedemann's *Annalen* W. von Uljanin describes an interesting series of experiments on the E.M.F. produced by the action of light on selenium. Fritts, an American observer, had used gold leaf electrodes, but the gold leaf is very liable to peel off, and the author, therefore, discarded it in favour of platinised glass plates. Thin layers of platinum possess the additional advantage of allowing all the rays of the spectrum to pass with equal freedom. The selenium was melted in between the two plates, fixed parallel to each other, cooled under pressure, and then reduced from the amorphous to the sensitive crystalline form by being heated once or twice up to 195° in a paraffin bath, and then allowed to cool slowly.

The following experimental results were obtained:—

(1) The effect of exposing one of the electrodes to the action of light is to produce an E.M.F. from the dark to the illuminated electrode. The highest E.M.F. obtained was 0·12 volt, and it was always found to disappear completely and instantaneously when both electrodes were darkened. The difference in the behaviour of different plates was very slight.

(2) Plates prepared by other methods were found to give very variable results, some giving an E.M.F. in the same direction when

*Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the author.

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either electrode was illuminated, but the effect was in these cases always greater when the negative electrode was the one exposed to the light.

(3) If the electrodes are kept joined through a wire for many hours the current from the dark to the illuminated electrode continues to flow with undiminished strength.

(4) When both electrodes are illuminated together the current can be weakened to any desired extent or reduced to zero.

(5) The action of light is instantaneous.

(6) Many of the plates were found to be subject to polarisation, but it had no effect on their sensitiveness to the production of E.M.F.

(7) When the E.M.F. of polarisation has attained a sufficiently high value it is diminished by the exposure of either electrode to the action of light. For smaller values of the E.M.F. the effect of light is of the normal character described under (1). The limiting value below which the effects of light were normal was found to vary considerably for different specimens.

(8) The resistance, and the sensitiveness to the production of E.M.F. when exposed to light, in general diminish gradually with lapse of time.

(9) Both the resistance and the sensitiveness to the production of E.M.F. are much increased by passing alternate currents from a small coil through the plates, and those which have lost their sensitiveness through lapse of time can be restored to their original condition by continuing this treatment for a sufficient length of time.

(10) With weak sources of light, and when the heat rays are excluded as completely as possible, the strength of the current is found to be proportional to the intensity of illumination of the electrode; but with stronger sources of light, without exclusion of heat rays, the current strength increases more slowly than the intensity of illumination. The E.M.F. in this case seems to increase more slowly than the conductivity.

(11) In the diffraction spectrum the orange-yellow rays were found to produce the greatest effect, and the greenish-yellow rays in the prismatic sprectrum.

The initial resistance of the specimens employed varied from 40,000 ohms to 900,000 ohms in the dark. The resistance of the specimen with the latter initial resistance gradually increased up to 1·4 megohm. The plates prepared by the author's method were found to be exceptionally sensitive to the action of light on their resistance, the effect of exposure to light being to diminish the resistance to about one-ninth of its initial value.

The author explains the results obtained on the hypothesis that the selenium in the plates exists in several allotropic forms, some only of which are sensitive to the action of light with respect to the production of E.M.F. He further supposes that some of the particles consist of combinations of different allotropic forms, or of selenides of the metals, of which traces existed in all the specimens experimented on. The effect of light he assumes to be to transform the sensitive particles into others electro-positive to them, and to facilitate the re-combination of the electrolytic molecules which have been taken up by the passage of the current.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

August 21, 1889.

13,154. T. MATHER and W. E. SUMPNER. London. Improvements in constructing or winding coils for electrical apparatus.

13,168. A. MCCANDLISH and S. H. HEYWOOD. Bredbury. Supporting electric lamps on the surfaces of iron or steel structures by means of a magnet, and preserving from abrasion its conductors.

13,172. F. V. ANDERSON. London. Improvements in conduits for laying underground electrical conductors, and in the means for supporting, guiding, and insulating the said conductors therein, and in clips for holding together the strips of conductors constructed of thin strips of metal.

13,183. J. RADCLIFFE. East Retford. Improvements in apparatus and in the combination thereof for lighting railway carriages, tramcars, and other vehicles by electricity.

13,191. T. A. D. FORSTER. United States. An electro-magnetic protector for electrical instruments.

August 22, 1889.

13,223. C. W. BEESLY. London. Improvements in electrodes and filaments for electric lamps, and in materials for the same.

13,273. C. JULIAN. London. Improvements in arc lamps.

13,282. G. F. SLATTER. London. Improvements in electric lamps, and means for securing electric lamps in carriages and like vehicles.

August 23, 1889.

13,323. W. SMETHURST. London. An improved method of carrying main leads and other electric wires along streets and other thoroughfares.

13,336. C. WELLS and J. BROWN. London. Improvements in electric arc lights.

August 24, 1889.

13,344. W. P. THOMPSON. Liverpool. Electro-therapeutic cap (T. Biermann, Germany).

13,382. M. BECKERS. London. An improved electric alarm or water level indicator, chiefly applicable to the water-gauges of steam boilers.

August 26, 1889.

13,444. F. REISINGER and W. WENZEL. London. Improvements in dynamo machines and the application thereof for regulating electric arc lamps and other purposes.

August 27, 1889.

13,459. G. DOWNING. London. Improvements in the construction of electric accumulators (J. F. Weyde and F. Clas, Austria, and J. Elsner, France).

13,480. W. P. KOOKOGEY. Glasgow. Apparatus for charging storage batteries and other purposes.

13,510. W. B. LAWRENCE. London. Lamp shades or reflectors for incandescent lamps.

13,541. C. R. BONNE. London. Improvements in electric wire and pole connectors (Messrs. Mix and Genest, Limited, Berlin).

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The best for overhead Telephone and Telegraph Lines,
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13,553. E. EDWARDS. London. Improvements in electrical signalling apparatus for preventing collisions between trains on railways (T. Perls, Germany).

13,557. J. Y. JOHNSON. London. Improvements in or connected with holders or sockets for incandescent electric lamps (J. W. Collier, United States).

August 28, 1889.

13,580. G. H. REDFERN. Staveley. An electric body belt.

August 29, 1889.

13,636. F. HUGHES. London. Improvements in the manufacture of indigo by the application of electricity (Æneas J. McDonald, East Indies).

13,640. W. THOMPSON. London. Improvements in electric switches.

13,658. H. LUBLINER. London, Improvements in automatic transmitters for telegraphic purposes.

August 30, 1889.

13,675. W. E. LANGDON. Derby. Improvements in the arrangements and apparatus for electrically lighting railway trains.

August 31, 1889.

13,756. A. T. COLLIER. London. Improvements in telephone receivers usable also as transmitters.

13,778. C. H. MARTIN. Middlesborough. Improvements in electric bells and in apparatus for use in connection therewith.

September 2, 1889.

13,800. G. E. HEYL. Germany. Improved supports of secondary batteries.

13,818. V. H. ERNST. London. Improvements in secondary batteries. [Date applied for under Patents Act, 1883, Sec. 103, February 12, 1889, being date of application in the United States.]

13,832. J. T. GREENWOOD. Liverpool. Improvements in insulators for supporting electric telegraph wires or the like.

13,838. A. W. HEAVISIDE and R. C. JACKSON. London. Improvements in means or devices for use in the distribution of electrical currents.

September 3, 1889.

13,841. M. WHELESS. London. A new and useful telegraphone.

13,859. E. J. HOUGHTON. Dulwich. Regulator for electric lighting.

13,860. M. F. RONALDS. London. A new shade for oil, electricity, or gas lamps.

13,864. S. C. C. CURRIE. Birmingham. Apparatus for automatically charging secondary batteries or accumulators.

September 4, 1889.

13,924. W. J. S. BARBER-STARKEY. Manchester. Improvements in electric incandescent lamp holders.

13,926. E. G. RIVERS. Clevedon. The construction of vessels for containing chemical liquids for battery cells and other purposes.

13,960. A. L. SHEPARD. London. Improvements in and relating to apparatus, chiefly designed for measuring electric currents.

September 5, 1889.

13,990. J. R. SCHILLIER and C. MEYER. London. Improvements in electro-magnetic apparatus for automatically opening and closing passages for gases, liquids and the like.

13,992. A. SLATTER. London. Improvements in electrical switches.

13,993. G. E. B. PRITCHARD and H. R. LOW. Stortford. Improvements in electrical safety fuses.

14,011. A. L. SHEPARD. London. Improvements in switches for opening and closing electrical circuits.

14,017. B. VERITY. London. Improvements in conduits for conductors of electrical energy.

September 6, 1889.

14,047. T. H. PARKER. Newbridge. Improvements in electric motors.

14,061. T. W. WATSON and A. H. WATSON. London. Improvements in electric ship's binnacle and telegraph or indicator lamps.

SPECIFICATIONS PUBLISHED.

1888.

10,209. MAQUAIRE. Electric regulator. (Price 1s. 3d.)

11,529. TOWLE and LANGDON. Indicators for electric light switches. (Price 6d.)

11,809. MAURICE and others. Measuring electric potential, &c. (Price 11d).

12,376. WISE (Van Gestel). Electric accumulators. (Price 8d.)

13,473. SHERRIN and SHERRIN. Electric launches. (Price 8d.)

14,426. SNELL. Electric switches. (Price 6d.)

14,622. CRAVEN. Variable adjustable resistance for electric currents. (Price 8d.)

14,932. MAQUAY. Electric lamps and batteries. (Price 8d.)

17,978. FARQUHARSON. Telegraphing. (Price 6d.)

1889.

613. NAYLOR and NAYLOR. Combined electric lamp-holder, fuze and switch. (Price 8d.)

1,421. SYKES. Voltaic electric belts. (Price 6d.)

2,297. SMITH (Hellesen). Galvanic dry elements. (Price 6d.)

2,375. WILKINS. Telephones. (Price 8d.)

2,480. LAKE (Cutler). Measuring electric currents. (Price 1s. 1d.)

5,014. VAN DEPOELE. Electric railways. (Price 8d.)

5,737. BERNSTEIN. Holders for electric glow-lamps. (Price 8d.)

6,078. GOBERT. Electric arc lamps. (Price 6d.)

8,360. HOLCOMB. Telephone systems. (Price 8d.)

8,552. NAHNSEN. Electrolytic separation of aluminium, &c. (Price 4d.)

8,619. SIEGMANN. Electrical alarm for steam boilers, &c. (Price 6d.)

8,855. HARRIS and CAMERON. Secondary batteries. (Price 6d.)

9,153. ARNOLD and CORYELL. Dry galvanic battery. (Price 6d.)

9,300. LAKE (Lemp). Dynamo electric machines. (Price 8d.)

9,376. HARRIS. Miners' electric lamps. (Price 8d.)

9,576. LAKE (Von Choate). Incandescent electric lamps. (Price 11d.)

CITY NOTES, &c.

CHILI TELEPHONE COMPANY.—Application has been made to the Stock Exchange Committee to appoint a settling day, and to grant a quotation for shares Nos. 1—40,000 of this company.

ENDOLITHIC IVORY COMPANY (LIMITED).—Registered on the 28th ult., with a capital of £10,000, in £1 shares, to establish manufactories for the process known as Dr. Hand Smith's "Endolithic process" for sinking and fixing colours, marks, and designs in, upon and under the surfaces of various substances.

INDIAN LIGHT RAILWAYS (LIMITED).—A company has been formed for the purpose of negotiating for permission to use any tramways or railways in India or elsewhere, and the rights, interests, and privileges of any concessions of tramways or railways which the company may deem necessary or convenient for any of its purposes. The company is registered by Clarke, Rawlins and Co., 66, Gresham House, E.C.

SCHMIDT-DOUGLAS ELECTRIC COMPANY (LIMITED).—An announcement is made in our advertising columns that the business of this company, now in liquidation, is to be sold as a going concern, together with the plant, &c., of the electric light stations at Bradford, Halifax and Leeds. Further particulars will be found in the advertisement.

BUSINESS NOTICE.—Mr. John Spencer, of the Globe Tube Works, Wednesbury, and of 3, Queen-street-place, Cannon-street, E.C., announces that he has *reduced* his discounts for wrought iron tubes and fittings 2½ per cent. on the gross. Mr. Spencer issues a neat and handy card price-list.

CHANGE OF ADDRESS.—The proprietors of our contemporary, *Industries*, have decided to establish their chief offices in London, at 358, Strand, W.C.

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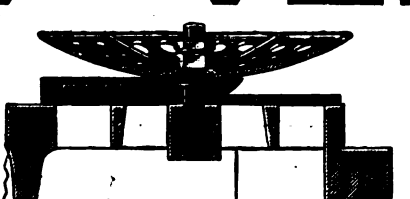
No Rubber, Percha, or Leather.



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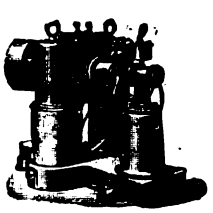
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Sept. 11, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 11, 1889.	
							Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.			
1,770,360	Stock	15/0	Anglo-American	52 53	4 14 4	Jan., Apr., July, Oct.	52⅝	52½
2,614,820	Stock	30/0	Do. Preferred	88 89	5 12 4	,, ,,	89	88½
2,614,820	Stock	...	Do. Deferred	17½ 18	...	February	17⅞	17⅝
130,000	£10	5/0	Brazilian Submarine	13¼ 13⅜	5 16 5	Mar., June, Oct., Dec.	13⅜	13 5/16
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	..	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14⅝	14½
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3½ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10¾	5 16 2	Jan., Apr., July, Oct.	10¾	10½
380,000	10	5/6	Eastern	13⅛ 13⅜	4 14 6	,, ,,	13⅜	13⅛
70,000	10	3/0	Do. 6 per Cent. Preference	15¼ 15⅝	3 16 2	,, ,,	15⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109½	109¼
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	109	...
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	105 106	4 14 4	January and July	105⅞	...
179,177	10	4/0	Globe Telegraph and Trust	8⅜ 8⅝	8 7 3	Jan., Apr., July, Oct.	8 9/16	8⅝
178,992	10	3/0	Do. 6 per Cent. Preference	14⅝ 15⅛	3 19 4	,, ,,	...	...
150,000	10	5/0	Great Northern	15¼ 15⅜	4 15 3	Jan., July, and April	15¼	...
17,000	25	37/6	Indo-European	40 42	6 1 6	April and October	...	...
9,000	8	8/0	Reuter's	6⅜ 7¼	5 10 2	April and October	6¾	...
15,609	10	5/0	West African Telegraph	9 10	...	...	9½	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	...
30,000	10	5/0	West Coast of America	10 10½	5 14 3	January and July	...	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	2 1/16	2⅜
34,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12¼	12 1/16
4,669	10	*	Do. 6 per Cent. 2nd Preference	14 15	...	...	...	...
45,181	15	9/0	Western Brazilian	10⅜ 11¼	6 10 4	March & September	...	...
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	¼ ⅜	4 8 3	...	...	...
55,000	5	...	United River Plate	5¼ 5⅜	...	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 4	...	...	...	...
23,692	5	2/0	Do. (fully paid)	4½ 5	...	February & August	4⅝	...
79,934	5	...	Swan United (£3. 10s. paid)	4¼ 4½	...	...	4 13/16	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 45	5 6 8	March and July	45	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	20	...

* No dividend since May, 1880.



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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 592.—Vol. XXIII. FRIDAY, SEPTEMBER 20, 1889. Price Fourpence.

NOTES.

The highly successful meeting of the British Association which has just been brought to a close will not, in spite of its success, be memorable for any great advance in electrical science. The Newcastle meeting has been distinguished rather for the large number of electrical Papers possessed of high average merit, and bearing witness to the vast amount of patient detailed work which is being carried out, mainly in the laboratories of our technical colleges in all parts of the country. Papers of this description afford a welcome, though scarcely needed, demonstration of the vitality and of the thoroughness (so to speak) of Physical Science in the England of to-day, and "practical men" should, we think, heartily congratulate themselves on the existence of Institutions, and still more upon the unfailing supply of qualified men by whom such invaluable labours can be so successfully pursued. We do not, however, propose this week to offer any detailed comments upon the class of Papers to which we here more particularly allude. In our next issue we shall publish a "*Résumé* of the Electrical Papers read before Section A," from the pen of Dr. Oliver Lodge. Readers of *The Electrician* will not fail to remember the remarkable Paper, under the same title, which appeared in our columns at the close of the Bath meeting a year ago.

We shall, therefore, chiefly confine our remarks this week to the work of a more immediately practical kind, which has been brought before the Association this year. This leaves us with a fairly wide field for comment. Taking first the Papers read in Section A in chronological order from the list, which will be found in another column, we might, perhaps, be expected to say something about the Report of the Committee on the Magnetisation of Iron, and upon the Papers of Prof. Ewing relating to Hysteresis. The first of these was, however, merely preliminary and historical, and the second, though deeply interesting and important, dealt only with magnetisations which, from an engineer's point of view, may be considered microscopically small. We pass on to Tuesday morning, when Prof. Blyth exhibited a "New Form of Current Weigher." In this instrument, of which only rough models were shown, Prof. Blyth has endeavoured to overcome the difficulty of introducing the current into the moving coils by an ingenious application of the principle of the Roberval balance, in which the usual jointed connections are replaced by tightly-stretched torsion wires. The electrical connections are such that only one-half the current flows through any one torsion wire of the frame. In one pattern the coils are in a vertical plane, and the current is measured by the number of degrees of torsion that must be given to one end of one of the torsion wires in order to bring the balance to equilibrium. In this case the wire whose torsion rigidity is used to measure the current does not itself carry the current to be measured. It is obvious that the range of this type of instrument must be small compared with other types, since the limit of the permissible diameter of the torsion wires is soon arrived at, and any sensible heating of the wires would obviously introduce error. Prof. Perry exhibited some standards of self-induction—a piece of apparatus which is certainly fated to become more familiar to practical workers as time goes on.

We now come to what was beyond question the most important announcement (from the practical electrical standpoint) made during the meeting. This was nothing less than an entirely new and vastly simplified voltmeter, by Prof. Perry. We have for many years been in the habit of expecting (and obtaining) from Profs. Ayrton and Perry an improved voltmeter at intervals of about fifteen months. Writing without book, it is really impossible to recollect all the diverse types of volt and ammeter which have successively issued from the prolific laboratory of these Professors. We entertain, however, a lively recollection of the last occasion on which Prof. Ayrton displayed at the Institution a vast array of spider-web and bicycle-wheel diagrams, and announced the advent of the long-range-hot-short-wire voltmeter. It was a beautiful instrument, but we are, we believe, revealing no secret when we mention that six separate adjustments were required in its manufacture. This peculiarity could not be classed amongst the advantages of this type, and it may even go some way to account for its almost total absence from the open market. Great is the contrast betwixt the now discarded bicycle-wheel and the new "Twisted-Strip Voltmeter," in this and almost every other respect. It is really impossible to conceive of anything more simple as a means of accurate measurement than this beautiful instrument. At first sight the twisted strip looks like an Ayrton and Perry magnifying spring, such as they have employed in so many recent applications (including the bicycle-wheel voltmeter itself), but in reality it is an even simpler affair. A strip of metal—preferably platinum-silver—is fixed at each end, and made red hot, then seized in the middle by a pair of pincers, and twisted round until it attains a permanent set. The

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twist on either side of the centre is of course in opposite directions. Such a strip possesses the property that when subjected to a moderate longitudinal strain its centre rotates, whilst its extension is very slight. The voltmeter consists, therefore, of such a strip carrying at its middle point a suitable index and subjected to a permanent longitudinal stress which has been just sufficient to give the pointer one complete rotation. If, therefore, a current be sent through the wire, the expansion due to the rise of temperature relieves the strain and permits the pointer to rotate through a certain number of degrees. We need not add anything more to show the wonderful simplicity and practicability of the apparatus. Its delicacy is also equally remarkable. As for the range, we believe that Prof. PERRY has not at present gone beyond 50 volts in a direct-reading instrument; for alternating currents a suitable transformer is easily provided. For a reduction as great as from 2,000 to 50 volts a transformer of quite small dimensions serves the purpose. Another highly interesting method by which the range may be extended is by the use of a twisted strip made of *carbon*. Messrs. WOODHOUSE and RAWSON have supplied Prof. PERRY with some twisted carbon strips of marvellous delicacy and, of course, of much higher resistance than the platinum silver. We see no reason to doubt that in this voltmeter the electrical world will find an instrument admirably adapted both for laboratory and for commercial purposes. It ought also to be conspicuously inexpensive.

IN the Paper by Mr. W. H. PREECE "On the Relative Effects of Steady and of Alternate Currents on Different Conductors" we have the record of an extensive and careful series of experiments directed to a definite practical end. We have all learnt a great deal within the last eighteen months with regard to the tendency towards a peripheral distribution of alternating currents in conductors. The extent to which this phenomenon occurs depends upon the frequency of the alternations, and upon the diameter and material of the wire. Mr. PREECE sought to determine by direct experiment whether the effect was perceptible under the ordinary conditions of alternate-current working. The answer is—as regards copper conductors of such sizes as are used in practice, and with periods ranging from 60 to 107—that no increased loss of energy due to the effect in question is observable. Mr. MORDEY has, we believe, also arrived experimentally at a similar result. It is, however, to be regretted that Mr. PREECE was not able to increase his frequencies or to maintain the same mean current density in wires of larger diameter until the practical limit of the effect was arrived at. We are pleased to learn that the experiments are to be continued, and it is to be hoped that arrangements will be made permitting such observations to be undertaken. In iron wire, owing to circular magnetisation, the limit is, of course, arrived at much earlier. The effects become somewhat complex, and, as Dr. LODGE has shown, when pushed to the limit with high frequencies some very paradoxical results ensue. We must not, however, be tempted to enter upon this side of the subject at the present moment.

THE last of the Practical Papers in Section A was one by Prof. SILVANUS THOMPSON, "On Sparkless Electro-Magnets." The practical upshot of Prof. THOMPSON'S research amounts to this, that the most effective means for the prevention of sparking on opening a circuit containing the coils of an electro-magnet is to surround the core of the magnet with a substantial shield of copper. Of course, there are many cases which arise in practice where this would be impossible. We could not, for instance, adopt it in any case with alternating currents, but, fortunately, as is now pretty generally known, under similar conditions of E.M.F. and current density the alternating-current spark is a very much feebler affair than the continuous-current one. Again, the device does not admit of use in armatures; but we are inclined, notwithstanding, to believe that it would be well worth while to adopt this precaution for the field-magnets of series-wound high-tension dynamos. We believe that certain makers already do this, at least in certain cases.

TURNING now to Section G, we have referred to the Papers of Mr. SWINBURNE and of Major-General WEBBER in another column. Mr. MANVILLE gave a lucid account of the work carried out at Northfleet, where an electric tramway on the series-system has now been in quite successful operation for about five months. The detailed arrangements were fully described and illustrated in *The Electrician* of March 15th. When this line was first constructed some feeling of anxiety was naturally experienced, at least by those not connected with the work, as to the probability of the successful operation of the "spring-jacks," but after the experience of five months, in which it has not been found necessary to make any alterations in the original design, we think it may be reasonably believed that the method is a thoroughly practical one. We hope shortly to lay before our readers an account of a remarkable, and perhaps somewhat unexpected, development of series electric traction. With regard to Mr. WEBSTER'S Paper on "The Electrical Purification of Sewage," it is highly satisfactory to know that the large-scale experiment which is now being tried at Erith continues to give such excellent results. The question resolves itself into one of cost pure and simple, for it has been shown that any required degree of purity can be obtained in the effluent if the expense be not considered.

IT was interesting to learn from Mr. PREECE that the question of Telephonic communication between London and Paris is being seriously considered. As to the possibility of effecting the communication there can be no question—whether it will pay is another matter. Mr. KILLINGWORTH HEDGES described an ingenious form of safety-valve for use with transformers, which we described at the time when it was shown at a recent Royal Society *soirée*. Finally, Prof. FORBES gave a very favourable account of his experience with an electric launch which he hired from Messrs. IMMISCH whilst staying on the river near Maidenhead.

THE Committee of Section A has decided to adopt *en bloc* (with an exception to be mentioned) the decisions of the recent

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International Congress as regards nomenclature. Instead of the term *resistance fictive*, defined as the ratio of the "effective" E.M.F. to the "effective" current, they have adopted the term "impedance," defined by the well-known formula which expresses the "apparent resistance" in terms of L, R and *n*, *when the current wave is sinusoidal.* We think that this definition will meet with general approval. The authorisation of the term is the more satisfactory to ourselves since it was first proposed in these columns by Mr. OLIVER HEAVISIDE, and was consistently employed by us long before it came into common use.

WHEN Mr. PREECE, in Section G, hazarded the observation that it was the most difficult thing in the world—or words to that effect—to kill a man by electricity, it was certainly understood by those present as a mere *obiter dictum*, and not as a scientifically-accurate statement. Probably no one has been more surprised than Mr. PREECE to see this remark put forward in the London and the New York papers as his deliberate opinion, or to find in yesterday's *Times* that it has resulted in a challenge from a Brighton doctor to "lay hold of a 2,000 volt electric wire." The fact is, as every electrician knows, that a deadly shock can, if necessary, be administered with fatal facility. The problem, which has been discussed in New York with such a strange degree of gusto and so much bad taste, is somewhat different. It was made a *sine quâ non* to kill without disfiguring, and to this end it was proposed to resort to wet sponge electrodes and similar methods. We shall be thankful to hear the last of this unpleasant business, but we cannot deny that electricity can destroy life.

THE sudden change of front of the Exeter Town Council with regard to overhead wires argues at the best but little foresight on the part of that body. The permission granted in June to the Exeter Electric Light Company to run its cables overhead is now—if a large number of the Corporation succeed in having their way—to be withdrawn on no better grounds than that here and there the wires run too close to the houses, and that the standards are "sadly disfiguring." An underground system is doubtless an advantage from an æsthetic, if from no other point of view, but in a town like Exeter, where the demand for current will probably be comparatively small for some little time, it seems somewhat unreasonable to expect such an expensive luxury at once. The Corporation presumably gave its consent with its eyes open to the fact that electric light wires were not exempt from the action of gravity, but required supports, and it was moreover provided with a plan showing the proposed positions of the posts; so that to withdraw its permission now that the company has expended a large sum of money would be, so far as we can see, utterly inexcusable. As to the dangerous proximity of the wires to the houses, we have no doubt the company would be perfectly willing to make any feasible alteration.

As will be seen elsewhere, the Paddington Vestry are about to consider yet another report on the subject of electric lighting. The first report submitted to this body was, it will be remembered, that of Mr. S. J. MACKIE (*Electrician*, December 21, 1888), who in September last worked out a 37 or 50 per cent. profit to the Vestry from its proposed central station on the basis of a total annual output of 3,186 hours under full load. At the beginning of April a second and carefully-considered report (*Electrician*, April 12, 1889) was sent in by Prof. GEORGE FORBES, and now the Electric Lighting Committee, after lengthy deliberations, have issued their report, making the third within twelve months. The Committee recommend that the work should be entrusted to some well-established company, which, in view of future purchase, is to have its station and mains entirely within the parish. The system preferred by the Committee is that of storage-batteries and sub-stations.

A CORRESPONDENT writes as follows:—"I was with a friend at the Birmingham Exhibition endeavouring to fathom the mysteries of WOOLRICH'S historical plating machine, which, it may be admitted—without any slur upon the venerable machine or its inventor—might, by the uninitiated, be mistaken for anything, when we became conscious of an unprotected spinster of tender (?) age and anxious countenance hovering around us. Said the unprotected one, on catching our attention, 'Oh, if you please, will you weigh me?' The mistaken one was directed a few stalls lower down to where the delicate operation could be performed with the aid of the incompressible fluid which has just been dislodged from its ethereal entanglement."

Bradford.—The municipal central lighting station will be inaugurated at noon to-day by the mayor.

Innsbruck.—The municipal central lighting station erected by the firm of Ganz and Co. is now completed.

The Electric Light on the River Steamers.—The Victoria Steamboat Association are lighting some of their steamers by electricity.

Interruption of the Tangier-Gibraltar Cable.—Telegraphic communication between Tangier and Gibraltar is interrupted, the cable across the Straits having broken down.

Altona.—The Zoological Gardens of this town are now lighted at night by 30 arcs and a large number of incandescents. The work was undertaken by Messrs. Heirwicke and Goos.

Indian Telegraph Service.—It is probable, says *Indian Engineering*, that Colonel Mallock, Director-General of Telegraphs in India, will be allowed a year's extension of office.

Dewsbury.—At a meeting of the Dewsbury Town Council last week it was decided to oppose all applications which may be made by electric lighting companies for supplying the borough with electric light.

Newcastle.—Final approval has been given by the Newcastle Town Council to the licenses of the Newcastle and District Electric Lighting Company and the Newcastle-upon-Tyne Electric Supply Company.

Airdrie.—At a recent meeting of the Airdrie Council it was resolved to proceed with the necessary advertisement of the Council's intention to apply for a Provisional Order in regard to the electric lighting of the town.

Brunnen.—The village of Brunnen, on the Lake of Lucerne, is lit by electricity, the motive power being obtained from the turbines at the spinning mill of M. Shach, where over 200 horse-power is available for electric lighting purposes.

Burslem.—The Town Clerk has been instructed to write to the Midland House-to-House Electricity Company and the Municipal Electric Light and Power Corporation, informing them that the Town Council will not consent to their applications for Provisional Orders.

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Lectures on Dynamo Machines.—Mr. W. B. Esson will deliver a series of twelve lectures on dynamos at the Hanover-square School of Electrical Engineering on Wednesday evenings, commencing on October 16th. Further particulars will be found in our advertisement columns.

Personal.—We are informed that Mr. Parsons, who had the management of the Sunbeam Company's Lamp Works at the time when the Super-incandescent—afterwards called the Sunbeam Lamp—was initiated and perfected, has resigned all connection with the Sunbeam Lamp Company.

Worcester.—At the Watch Committee meeting on Friday last, the Town Clerk pointed out that several companies had given notice to apply for Provisional Orders authorising them to supply electricity to the city, and it was eventually resolved not to recommend the Corporation to move in the matter.

Southport.—The Gas Committee of the Southport Corporation have resolved that an intimation be given to all parties who have given notice of their intention to apply for Provisional Orders to supply electricity within the borough, that the Corporation intend to withhold their consent to such applications.

The Edinburgh Exhibition.—At a meeting of the Executive Council of the Edinburgh Electrical Exhibition, held on Thursday last week, a letter was read from the Marquis of Lothian, K.T., accepting office as President of the Exhibition. The Dundee Town Council have contributed £200 towards the guarantee fund.

Glasgow University.—It is officially announced that the Queen has been pleased, on the recommendation of the Secretary for Scotland, to appoint Prof. Archibald Bart, of the Yorkshire College, Leeds, to be Professor of Civil Engineering and Mechanics in the University of Glasgow, in the room of Prof. Thomson, resigned.

Sheffield.—The Improvement Committee of Sheffield has recommended the Council not to give its consent to any license or Provisional Order being granted to the Sheffield Telephone Exchange and Electric Lighting Company, on the ground that the Council may probably itself seek to obtain powers necessary for electric lighting.

San Sebastian.—The plant at the central lighting station of the San Sebastian Gas Company comprises a multitubular Collet boiler, a 65 horse-power Corliss engine, and two Oerlikon dynamos giving 200 amperes and 130 volts. The charges are 2fr. 50c. per arc lamp per hour, and 6c. per 16 candle-power incandescent lamp per hour.

Chester.—A special meeting of the Town Council was held on Wednesday for the purpose of considering the desirability of making application for a Provisional Order under the Electric Lighting Acts. A resolution to the effect that powers should be applied for was carried unanimously, and it was decided to refer the matter to the Watch Committee.

Finsbury Technical College.—The evening classes at this institution comprise special lectures on hydraulic machinery by Prof. Perry, lectures and instruction in drawing-office work, together with courses for apprentices and others in mechanical and electrical engineering, technical chemistry, etc. For further particulars see our advertisement columns.

Leamington.—As things stand at present, the contract with Messrs. A. Chamberlain and G. Hookham for the supply of electricity to the Parade lamps terminates at Christmas. Several members of the Corporation are, however, in favour of negotiating with Messrs. Chamberlain and Hookham with a view to improving the present system of lighting the Parade by electricity.

The City of London College.—We have received from the City of London College, Moorfields, E.C., a copy of the syllabus of lectures for the ensuing session. Classes are devoted to Civil and Mechanical Engineering, Surveying, and Technical Drawing. The engineering department is under the care of Prof. Henry Adams, M.I.C.E. The Michaelmas term commences on Monday, September 30th.

Falmouth.—At a recent meeting of this body the following resolution was moved :—"That the time has arrived when this authority should apply for an Act of Parliament for powers to supply Falmouth with electric light, and that the parish Local Board, the Penwerris Lighting Committee, and the Corporation of Penryn be asked to join in the scheme." The matter was referred to the Lighting Committee.

Goulburn (New South Wales).—Tenders are to be called for lighting the streets and parks of Goulburn by electricity, with or without the right of supplying private persons with light for commercial or domestic purposes, but without the exclusive right of supplying labour and fittings for carrying the light into private properties. Two systems will be provided for in the specifications, so that the town will have the choice of either.

The Edison-Swan Company.—In the *Financial News* of yesterday a correspondent writes as follows :—"If 474 central electric lighting stations are promised to us (vide *The Electrician* of 13th inst.), and the average number of lamps lit by each station be 10,000, what will be the dividend paid by the above monopolists when the promise is fulfilled? I estimate that with lamps at their present price it should be something like 200 per cent."

The Electro-Harmonic Society.—The concerts of the Electro-Harmonic Society this season will be six in number, and will take place on the evenings of the following dates :—September 27th, smoking concert; November 1st, smoking concert; November 29th, ladies' night; January 31st, 1890, smoking concert; February 28th, ladies' night; March 28th, smoking concert. In arranging the programme for the concert on February 28th it is proposed to rely mainly on musical amateurs.

Mr. Edison in Berlin.—Mr. Edison arrived in Berlin on Thursday last week. On Friday he visited the Accident Prevention Exhibit. On Saturday morning he visited Charlottenburg, and viewed the works of Messrs. Siemens. He returned to Berlin on the "Electra," a boat fitted with electric motors. In the evening Herr Werner Siemens gave a grand dinner in his honour at Charlottenburg. On Monday Mr. Edison and Herr Siemens left for Heidelberg to attend the Congress of German Naturalists.

The Glasgow Technical College.—We have received the syllabus of engineering classes at this college for the Session 1889-90. We observe that Prof. Jamieson conducts a day workshop and two years' laboratory course for those who have not entered upon an apprenticeship, or who can leave their works during the winter months, as well as evening lectures for those who are employed in engineering establishments. The aim of these courses is to provide a sound practical knowledge of electrical testing, as well as of steam engines, gas engines, boilers and dynamos.

Arbroath.—At meetings of Arbroath Police Commissioners and Gas Corporation held on Monday it was unanimously agreed to refuse consent to the Scottish House-to-House Electricity Company to apply for a Provisional Order. It was further agreed to oppose the application if made, and to request the Board of Trade to give the local authorities time to consider the needs and desires of the community, and the desirability of the Gas Corporation itself applying for a Provisional Order authorising the Corporation to supply electricity within the limits of their Act of Parliament if such should be required in the locality.

Dundee.—At a special meeting of the Gas Corporation, held on Monday, the Corporation unanimously refused to give their consent to the proposed Provisional Order of the Scottish House-to-House Electricity Company, and resolved to oppose the application if made, and to request the Board of Trade to give to the Local Authority time to consider the needs and desires of the community, and the desirability of applying for a Provisional Order authorising them to supply electricity within the bounds of their jurisdiction. At a subsequent meeting of the Police Commissioners similar resolutions were likewise put and unanimously carried.

Great Yarmouth.—The Town Council at their last meeting received a report from a Special Committee, which stated that they had considered the report of the borough surveyor on the supply of the electric light throughout the borough, and that they had instructed him to prepare a further report showing

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the cost of an installation sufficient to light the public streets and roads in the borough. They recommended the Council that it was expedient to prevent any company from getting the electric lighting of the town into its hands, and to oppose the granting of the Provisional Orders now applied for by two companies. This report was adopted.

Exeter.—At the meeting of the Town Council on Wednesday last week the town clerk and the surveyor were plied with numerous questions with regard to the proceedings of the Electric Light Company. It was asserted that the overhead wires were being run far too close to the houses, and the posts were condemned as "sadly disfiguring." Finally a resolution directing the town clerk to make inquiries as to the regulations of the Board of Trade was carried, and notice was given that at the next meeting a resolution would be moved that the permission given to the Electric Lighting Company to erect posts and wires in the streets be determined at the earliest possible date.

Bristol.—The Electrical Committee, at their meeting on Wednesday last week, resolved to request Mr. Preece to prepare specifications to enable the Corporation to advertise for tenders for the supply of electric light by one of the systems of which they might approve. Mr. Preece, it will be remembered, stated in his report that in his opinion the proper system to introduce into Bristol was the alternate-current transformer system. He estimated that the Corporation ought to be prepared ultimately to supply 70,000 lamps, and that this would mean eventually a capital of £300,000. A commencement, he thought, might be made with a capital of £30,000 and a plant for 5,000 lamps.

Hove.—A special meeting of the Hove Commissioners was held on Thursday last week to take into consideration the expediency of applying for a Provisional Order under the Electric Lighting Acts, 1882 and 1888, to authorise the supply of electricity by the Commissioners for public and private purposes within the town of Hove. Mr. Woodruff, in moving that the Town Clerk be instructed to apply for a Provisional Order, reminded the members of the inquiry held recently in Brighton, and said that owing to what was said at that inquiry they were virtually pledged to do something in the matter. The electric light, he thought, was now within a measurable distance of being made financially a success. They incurred obligations by taking this Order. One of them bound them to supply a certain amount of lighting within two years of the granting of the Order, but they were probably not liable to any other penalty in the event of non-compliance but the revoking of the Order. He was not prepared to say that he should support a proposal that the Commissioners should undertake the electric lighting themselves. If they obtained the Order they might be able to hand it over to a good company upon terms which it would be to the interest of the ratepayers to accept. The motion was carried.

Uranium.—Exactly a century ago—namely, in 1789—Klaproth succeeded in isolating from a dark-coloured mineral known as pitch-blende a yellow oxide, which, after carefully testing, he pronounced to be the oxide of a new metal. To this metallic substance he gave the name of uranium, so calling it after the planet Uranus, then recently discovered by Herschel, and it was at once classed among the rare metals, and still remains so. Its rarity is indicated by its market price, which is about £2,400 per ton. Uranium is found in Cornwall, Saxony, and Bohemia; but up to the present time it has only been met with in isolated pockets and patches. The centenary of its discovery by Klaproth has, however, been marked by the finding of a continuous lode at the Union Mine, Cornwall. This discovery is regarded as unique in the history of the metal, for the lode is what is known as a true fissure vein, and the ore is found to contain an average of 12 per cent. of the pure metal, the assays going up as high as 30 per cent. in some parts of the lode. It is anticipated that the present discovery will enable several important applications of the metal to be followed up. Uranium may, for instance, be used as a substitute for gold in electroplated ware, inasmuch as with platinum and copper it forms two beautiful alloys, each having the appearance of gold, and the former also resisting the action of acids.

A Trip in the Electric Launch "Eta."—The following account of a trip to Oxford and back in Messrs. Immisch and Co.'s electric launch "Eta" may prove of interest. The launch, with three passengers on board, started from Hampton on Saturday, the 7th, and Maidenhead, 26 miles, the first stopping-place, was reached in about four hours. Here the cells were recharged during the evening at the charging station. On Monday morning the journey was renewed by a run to Goring, 34 miles, where the cells were again recharged during the night. At ten o'clock on Tuesday morning Goring was left behind, and, after two halts on the stream, Oxford was reached by four o'clock in the afternoon. During the two hours the "Eta" lay at Oxford she was an object of considerable attraction, being the first electric launch that has been above Goring. Leaving Oxford at 6 p.m., a stop was made at Abingdon for the night, Goring being reached by noon on Wednesday. A small charge was put in during lunch, after which the journey was resumed to Reading, which was left on Thursday morning at eight o'clock, and a short stay being made at Henley, Maidenhead, the end of the journey, was reached at 1 p.m. It will be noticed that the sixty miles from Goring to Oxford and back was accomplished with but one charge. The "Eta" has therefore made two records, one for distance and another for work.

The Rating of Machinery.—An important and largely attended meeting of manufacturers from all parts of England was held on Wednesday last week, at Bristol, to consider the attempts which have been made to assess all kinds of machinery to the local rates, and to consult as to the steps which should be taken to protect the interests of all those affected. It was unanimously resolved that a National society for the exemption of machinery from rating be formed among the machinery users of the kingdom, for the purpose of assisting manufacturers to resist illegal and excessive assessments. It was also resolved to prosecute an appeal to the Superior Courts against the recent decisions of the Somersetshire Quarter Sessions in respect of the machinery in the mills in the Chard Union, and to promote a Bill in Parliament which shall declare the law and render it free from any doubt on the subject. Mr. Humphreys Davies, F.S.I., rating surveyor of the Adelphi, London, was appointed secretary, and arrangements were made for a thorough organisation of the affected interests throughout the country. Subscriptions were paid or promised amounting to upwards of £2,000. The feeling of all those present was expressed strongly that the question was of great national importance, and that to rate machinery would be to place our manufacturers at a serious disadvantage in competing with foreign countries, as it would largely increase the cost of production.

Paddington.—On Tuesday the report of the Electric Lighting Committee of the Paddington Vestry as to the action to be taken by that body for the supply of electricity for lighting purposes in Paddington was issued. The report states that in the opinion of the Committee there seems little doubt that arc lamps are best for street lighting. The cost, the report goes on to say, is, however, difficult to arrive at owing to the great difference of opinion among experts as to the number required for effective lighting. Taking everything into consideration, the Committee think it advisable for the Vestry to entrust the work of electric lighting to a well-established company: and in view of the possibility of the local authority desiring to purchase at any future time the undertaking of any company in the parish, the Committee considered that it should be a *sine qua non* that the central stations for the production and supply of electricity should be constructed, and the distributing mains laid, so as to form a complete installation for Paddington, independent of all communication with other parishes. The Committee think the continuous-current system, in conjunction with storage batteries as supplied by the Chelsea company, preferable for electric lighting. Mr. Slater, electrical engineer, in his report to the Committee, urged that the Vestry should undertake the public and private lighting of the parish. He said that the parish, being, perhaps, the wealthiest in London, ought to be the best-paying place for electric lighting. In such a populous parish he believed that electricity could be supplied to private consumers at a rate equal to 4d. to 5d. per Board of Trade unit. A special meeting of the Vestry is to be held to consider the Committee's report.

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BROOKS' UNDERGROUND SYSTEM.

On Monday last we witnessed some experiments with the above system of underground mains with oil insulation at the works of Messrs. Johnson and Phillips, Charlton, Kent.

The conductor experimented upon consisted of seven No. 18 B.W.G. wires, each covered with textile matter to a diameter equal to No. 12 B.W.G., made up into cable and braided lightly over all. This conductor was 140 yards long, and was drawn into 1in. iron gas tubes, which had been laid for the purpose in Messrs. Johnson and Phillips' premises. In order that the conditions of the test might approximate as nearly as possible to those of ordinary working, the conductors were spliced at two points, splice boxes being provided in the tubes for this purpose. The object of the test was to show with what economy a good insulation may be obtained. The galvanometer employed to make the measurement had a resistance of 12,500 ohms, and when shunted with 10 ohms a deflection of 37deg. was obtained through 1·24 megohms. The battery employed consisted of 200 Leclanché cells.

Experiment 1.—One pole of battery was earthed and the other connected through galvanometer to one of the seven wires, the remaining six wires having their ends clear. After one minute's electrification the deflection of galvanometer was 15deg., showing the insulation to be $\frac{37}{15} \times \frac{12,500+10}{10} \times 1 \cdot 24 = 3,830$ megohms, or $\frac{140}{1,760} \times 3,830 = 306$ megohms per mile. Another wire was substituted for the first with the same result.

Experiment 2.—The same as the above, except that the remaining six wires were earthed. Three different wires were tested, giving respectively 240, 266, and 240 megohms per mile, or an average of 249 megohms per mile.

Experiment 3.—The whole of the seven wires were connected together at one end, and the aggregate insulation measured, the result showing an insulation resistance of 88 megohms per mile. In this experiment the conditions obviously approached more nearly those which would obtain in an electric light cable than in experiments 1 and 2. It will be noted that the last result would indicate a considerably higher value for each wire than that obtained when the wires were measured separately. This is always found to be the case with Mr. Brooks' system, and is, we think, accounted for by the fact that when tested singly leakage takes place from the whole surface of the wire, whilst when the seven wires are bunched probably no sensible leakage can take place from the inside wire or from the inwardly directed surfaces of the outside wires.

Experiment 4.—A 100-volt Kapp alternating dynamo was connected to a transformer, by means of which the E.M.F. was raised to 1,000 volts, as shown by running ten 100-volt Swan incandescence lamps in series across the terminals. Two of the seven wires were connected to the opposite lamp terminals, so that the insulation was subjected to an alternating E.M.F. of 1,000 volts. The results showed that the insulation could not be sparked through with this E.M.F.

Experiment 5.—Two pieces of $\frac{7}{18}$in. cable, with a thin covering of textile matter, had been twisted together, the ends being kept apart. The twisted ends were immersed in a bucket nearly filled with Mr. Brooks' oil compound, and the other ends brought up through two glass tubes. In this case more resin than usual had been put into the mixture in order to make it more manageable for the experiment. The terminals of a large induction coil by Messrs. Apps were now connected to the two ends of the cable, and after several unsuccessful attempts to prevent the discharge from leaping to the sides of the pail, during which several thicknesses of $\frac{1}{16}$in. sheet rubber were pierced, a nearly continuous stream of sparks, 7½in. long, was obtained between two bared places on the connecting wires. Thus, according to Mr. De la Rue's tables, an E.M.F. of something like 170,000 volts was withstood by the insulation between the twisted wires. After being subjected to this strain, a test with the galvanometer gave no readable result. Mr. Brooks states that he has subjected a similar arrangement to the above, but with several inches of water upon the top of the oil, to a test of one year's duration, the wires having been connected across the terminals of a 1,000-volt Brush circuit. No change of any kind had taken place at the end of this time, the insulation remaining as perfect as at first.

A specimen of cable was exhibited consisting of 510 No. 16 B.W.G. wires, each having only a very thin covering, there being less than $\frac{1}{32}$in. between the wires. The cable measures only 2½in. diameter over all, and is now in use in telephonic work. Upon completion 10 wires were found to be broken or faulty, leaving 500 good wires. The insulation of the separate wires in this cable varies from 6 to 14 megohms per mile, and it is a curious fact that the wires having the lower insulation were found to "talk" better than those with the higher. The lower ones have consequently been selected for connection with some long-distance lines.

Mr. Brooks states that he is able to draw 1,000ft. of his cable into a pipe without intermediate hand-holes; thus by drawing from the centre both ways a length of 2,000ft. can be drawn in.

A VISIT TO THE INSTITUTE OF MEDICAL ELECTRICITY.

In response to an invitation from the Directors of the Institute of Medical Electricity (Limited), we recently visited their central establishment at 24A, Regent-street, and found much to interest us.

After an introductory visit to the office and consulting room we were shown a large and cheerful-looking room, designated the men's room, in which, upon the wall, are fixed switch-boards arranged with suitable connections for supplying all the forms of current used in ordinary cases. One of these switch-boards is shown in Fig. 1.

Upon an ordinary table lay electrodes, pad, plate, and handle, of numerous shapes and sizes, together with flexible and well-insulated rheophores for connecting the electrodes to the switch-board, so that everything necessary for ordinary applications was ready to hand. In a cabinet near a strong reserve of similar electrodes was arranged, together with electrodes for electrolysis, dilatation, cautery, and other surgical purposes.

In one part of this room stands an ingenious apparatus for carrying out the electro gymnastic system (Lawrence's patent) whereby electric currents of suitable character and strength are passed through the limbs or whole body of patients during mechanical exercise, either passive or active. We give in Fig. 2 a sketch of the apparatus, the mechanical part of which is known as Chadborn and Coldwell's "Excelsior" gymnasium.

It is claimed that by means of this system weak or injured, and even paralysed limbs may, as long as their vitality is not entirely destroyed, be rapidly restored, and that the process is simple, natural and pleasant. For the treatment of spine curvatures, round shoulders, &c., and certain digestive troubles this system is also likely to prove beneficial. We were informed that the apparatus shown is only one of many forms in which the system will be applied, and that there is now in hand a form for the special treatment of writer's cramp.

In the ladies' room there is another switch-board similar to that shown in Fig. 1, and here we were shown some special electrodes designed by Dr. Arthur Harries, physician to the Institute, for the treatment of certain skin diseases by electrolysis. Some of these electrodes we illustrate in Fig. 3. We understand that this form of treatment is a new departure introduced by Dr. Harries, and promises to give good results.

The electrified room which we next visited is fitted in such a manner (Byng's patent) that the air-space between floor and ceiling is converted into an electric field by the use of alternating-currents of high potential. A slightly elevated platform stands upon glass insulators and covers all the floor of the room with the exception of a margin round of about 18in. This platform is covered with sheet lead, and is connected by well insulated wire to one pole of the secondary wire of a powerful induction coil. Above this platform, or floor, is placed an insulated

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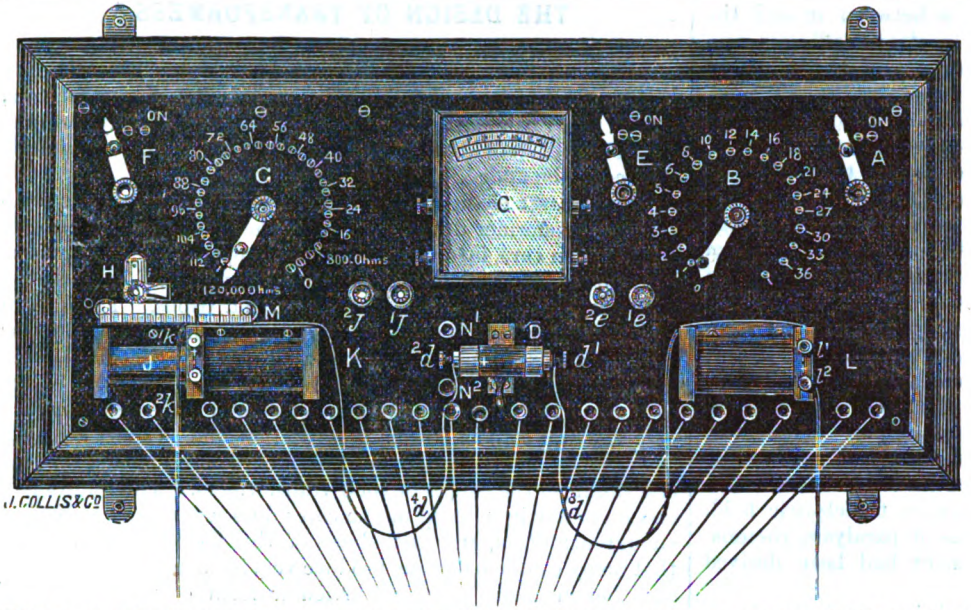
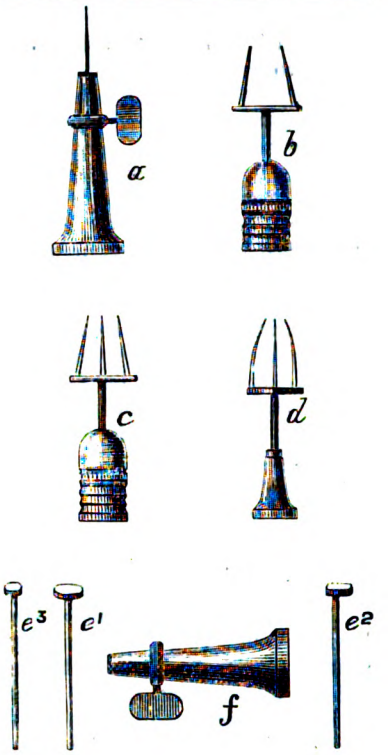


FIG. 1.—A, switch for the continuous-current circuit; B, dial collector for controlling no. of cells in circuit; C, galvano meter, graduated in milliamperes, and always kept in circuit with the patient when continuous current is administered; D, current reverser—a^1 and d^2, terminals of the continuous-current circuit, d^3 and d^4, flexible rheophores; E, switch of a separate circuit for lighting a small incandescent lamp used to examine cavities—e^1 and e^2, terminals of the lamp circuit; F, switch for the induction coil circuit; G, rheostat of 12,000 ohms in the primary circuit of the coil; H, contact breaker; J, primary coil—j^1 and j^2, terminals of primary coil; K, 10-ohmsecondary coil—k^1 and k^2, terminals of secondary coil; L, 2,000-ohm secondary coil interchangeable with K—l^1 and l^2, terminals of 2,000-ohm coil; M, scale graduated in millimetres showing the distance the coils K or L are passed over coil J; N^1 and N^2, terminals for connecting any of the coil terminals with d^1 and d^2 so that currents from both sides of the board may be drawn simultaneously.



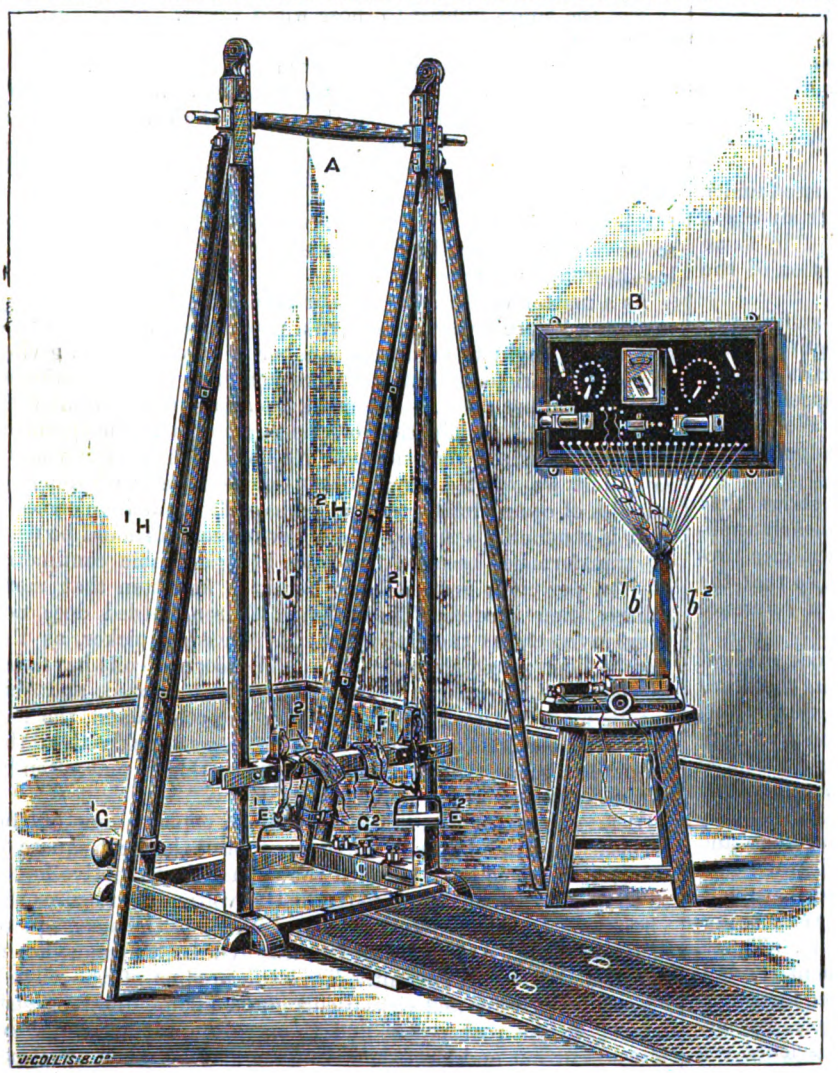


FIG. 2.

A, machine for mechanical exercise; B, general switchboard similar to that shown in Fig. 1—b^1 and b^2, conducting wires running under the floor to C; C, switch arrangement by variations in which the current may be passed at will through the whole or different portions of the patient's body; D^1 and D^2, insulated stand electrodes of fine wire gauze for conducting the current to or from the patient's foot or feet during exercise; E^1 and E^2, handle electrodes for conducting the current to or from the patient's hand or hands; F^1 and F^2, bandage electrodes for conducting the current to the arms or legs; G^1 and G^2, spring sliding contacts to which adjustable weights are attached; H^1 and H^2, conducting rods; J^1 and J^2, conducting flexible cords; K rheometer for measuring the resistance of patients by means of alternating currents and a telephone.

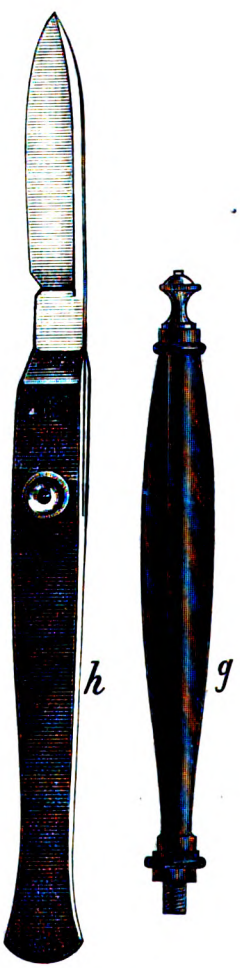


FIG. 3

a, needle used for the removal of hair; *b* and *c*, bipartite and tripartite instruments used in the simultaneous electrolisation of several points in a nodule; *d*, tripod arrangement used in the treatment of discrete nodules of lupus or scrofuloderma; e^1, e^2, e^3, three irregular-headed electrodes specially shaped to meet the requirements of a recent case of superficial nævoid developments; *f*, a base suitable for holding the electrodes shown in e^1, e^2, e^3; *g*, light insulated holder; *h*, ordinary surgical knife capable of electrical connection at its base, used, amongst other things in the treatment of enlarged facial or other veins

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ceiling of light brass work, the distance between it and the insulated floor being adjustable. This insulated ceiling is connected to the other pole of the secondary wire of the induction coil.

When the apparatus is in action a patient standing, sitting, or lying in the "field" becomes electrically influenced without experiencing any shock, or (in most cases) any of the sensations usually accompanying electrical action on the body; but if any two points on the body be connected to a telephone the passage of alternating currents is distinctly audible. The tonic effect of a short stay in the electric field is considerable, but the form of treatment most practised in this room is known as electro-manipulation, introduced by Mr. Lawrence, which consists of the manipulation of the patients' limbs or body, as in massage, while the patient is in the "field," and the manipulator is connected to "earth." Thus high potential alternating currents are concentrated under the hands of the manipulator where most needed, without any unpleasant sensation on the part of the patient, while at the same time the general tonic effect is obtained by reason of the patient's presence in the electric field. We were shown particulars of some cases of paralysis, rheumatism, anæmia, &c., in which marked benefit had been derived from this form of treatment.

The bath-room contains a large, well insulated oak bath, having connections conveniently arranged round it, with a switch-board somewhat similar to those already mentioned, but with a larger induction coil. Sponge, plate and bar electrodes of various sizes are used for the different forms of electric bath here administered, and all are ready to hand.

The experiment room contains several valuable pieces of electrical apparatus, and we examined some of the notes of experimental investigations in which, with the colaboration of several medical men and students, Dr. Harries and Mr. Lawrence are engaged. These researches will, we think, when completed, throw light on many points in electro-physiology and therapeutics at present obscure.

Here we also saw the first ozonised cabinet, constructed under a recent patent, in which it is proposed to treat certain chest diseases by strongly (electrically) ozonised air, aided in some cases by exercise to deepen respiration. Our description of the cabinet must be deferred for the present.

The battery rooms require no special comment—suffice it to say that all the electrical power used (with the exception of one Wimshurst influence machine) is, at present, obtained from primary batteries, and these are mostly Coxeter's special form of Léclanché. The electrified room was fitted by Woodhouse and Rawson (Limited), most of the other apparatus being supplied by Coxeter and Son.

A glance at the Treatment Book in the office shows that careful record is kept of all cases, for in it is entered each application administered, and the details in proper electrical measurements of E.M.F., current strength and resistance, so that the record can hardly fail to prove a valuable work of reference and of scientific interest.

We were also shown a prescription form on which medical men are invited to prescribe *in proper electrical terms* the doses of electricity they wish their patients to receive. Surely this is evidence of an advance in medical electricity, and we congratulate the directors of the Institute in having introduced such a form and in having found medical men able and willing to use it.

In the course of a pleasant chat with the courteous and energetic manager, Mr. H. Newman Lawrence, we learned that the work of the Institute is steadily increasing, and that medical men are giving, almost daily, fresh evidence of their appreciation of the opportunities and advantages it offers. This is as it should be, for here we find no electrical treatment is administered without medical sanction, and no sensational assertions regarding the marvellous curative powers of electricity are made; all is plain sober fact, as far as modern science can make it so. High-class instruments, skilled attendants, accurate measurements and careful records. We can hardly imagine an establishment better fitted for the difficult and unique work the directors have set themselves, nor managed in a manner more worthy the support of medical and scientific men, not to mention the public generally.

THE DESIGN OF TRANSFORMERS.*

BY JAS. SWINBURNE.

So much has been already said on the design of transformers, and so many calculations have been made and so many formulæ given, that it would seem at first sight as if there was little that could be added.

The greatest change that has taken place recently in the practice of transformer design has been the substitution of a continuous iron core, interlinked with the copper coils, for a straight core with wires wound on it, as in the Ruhmkorff coil and the secondary generators of MM. Gaulard and Gibbs. The idea in making this change is that the continuous iron core needs fewer current turns to produce a given induction, and this is generally considered to be of the first importance. With the object of getting the necessary excitation as small as possible, makers give the iron core as large a cross-section and as short a length as possible; and the tendency of designers is to increase the iron and diminish the copper of their transformers. The question of loss of power in heating of the cores does not appear to receive enough attention, and the object of this Paper is to point out that many common designs produce very inefficient transformers, and that in many cases a particular form of "open circuit" transformer is the best.

If a transformer with a full load output of 1,000 watts has a loss of 50 watts in the copper and 150 in the iron, its full load efficiency is 83·5 per cent. But suppose it is put in a house wired for, say, 17 lamps, the full load is on only very occasionally, about half the lamps being the usual maximum. The proportion of the lamps lighted to those wired varies. Some authorities take it that the average is equal to all the lamps on one hour a day; others say three or even five hours a day. If the full load is on two hours a day, and the transformer stands idle, merely keeping its iron hot all the rest of the time, its average efficiency is only 35 per cent. Many will at once say that the loss of 150 watts in a 1,000-watt transformer is absurd, and that modern transformers work at something like 98 per cent. full load efficiency. The figures generally given by makers are so obviously impossible that one is driven to conclude that the loss in iron is not measured.

As a matter of fact, the measurement of this loss is no easy matter. Before bringing forward a paper like this, it might be said that I ought to produce a number of accurate data, giving the loss at various inductions at various frequencies. Unfortunately, I cannot do so. We must, therefore, rest content with Prof. Ewing's determination of the curve of a single specimen of iron magnetised very slowly. No doubt it is perfectly accurate, but we want a great many curves taken with different samples of commercial iron, and perhaps different frequencies.

It is commonly assumed that a low induction should be used in transformers, because the heat lost per cubic centimetre of iron per cycle is then less; but it is forgotten that more iron is then needed. The volume of iron needed does not vary inversely as the induction; it increases quicker, as the iron is bent round the wire coils. The copper coils have also to surround more iron if its section is increased, and this entails more loss over resistance. On the other hand, the loss per cubic centimetre of iron increases more quickly than the induction, but not much more quickly, so that it may often be advisable to use a high induction.

Before going farther, it will be well to explain some of the terms used in this Paper. The square root of the mean square of the electromotive force is called the virtual electromotive force; so that an electrometer or non-inductive voltmeter measures the virtual electromotive force. The square root of the mean square of the current, or the current as measured by a dynamometer, is called the virtual current. Thus the product of the virtual electromotive force and virtual current on a non-inductive resistance give the real power, and so on. Roughly speaking, the virtual current and electromotive force may be taken as 10 per cent. greater than the mean electromotive force. Similarly, the virtual induction is measured by the virtual electromotive force

* Paper read before the British Association in Section G, Newcastle-on-Tyne, September, 1889. This Paper was discussed jointly with those of Major-General Webber and Mr. Killingworth Hedges. A full report of the discussion will appear in our next issue.

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it produces. The mean induction need never be considered, as the question of heating depends on the maximum induction. The virtual induction is thus a maximum of about 10 per cent. less than would be necessary to give the corresponding mean electromotive force. The maximum induction again depends on the excitation, and not on the mean excitation. To get a maximum induction of 1 needs a maximum current of 1; it needs a mean current of about $\frac{2}{\pi}$ or ·64, or a virtual current of about $\frac{1}{\sqrt{2}}$, or about ·7. But a maximum induction of 1 is equal to a virtual induction of about 1·1, so that a virtual induction of 1 needs a virtual exciting current of about ·64. As an example, suppose a long core of one centimetre cross-section wound with wire, and suppose with a direct current one ampere per centimetre produced an induction of 10,000. If the direction of magnetisation alternated perfectly uniformly at a frequency of 2,500 per second, it would induce one volt per turn of wire round it. But if the magnetisation does not increase and decrease perfectly uniformly, the mean electromotive force will remain one volt per turn, but the virtual electromotive force will be greater. Take now the case of an alternating current, and find what virtual exciting current will be needed to induce one virtual volt per turn at a frequency of 2,500. The virtual induction needed will be 9,000. This will need a maximum exciting current of ·9, or a mean current of ·9 × ·64, or a virtual current of ·9 × ·7, or of ·64. If the direct exciting current of 1 lost 1 watt in a given length of wire, the corresponding alternating current will lose only about ·4, or less than half.

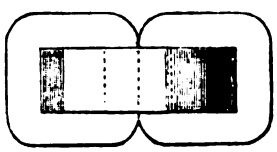

Fig. 1.

In making calculations to find the proportions which give highest efficiency it is clear that the interlinked coils must be as in the figure, in which the single link may be either the copper or the iron. If the cross-sectional area of the single link is equal to that of the pair, the pair will have less volume. If the waste of power per cubic centimetre of iron is greater than that of the copper, the wire will take the form of a pair of links, and the single link will be the copper wire. To get the best result the cross-section of the coil and core will be very nearly, but not quite, square. In the following calculations they have been assumed to be square, which can make no perceptible difference in the efficiency, and makes the calculations easier by removing two variables. The problem now proposed is: Given the desired output of the transformer, to design it to give the highest efficiency. Call the side of the section of the iron core x, and the side of the section of the copper core z. All the other dimensions of the transformer depend on x and z. We now have to find the loss in the transformer in terms of known quantities, and of x and z, and have then to choose x and z so as to make this loss as small as possible.

The waste in the iron core is equal to the waste per cubic centimetre of iron multiplied by the volume of the iron. Call the loss per cubic centimetre at the induction and frequency under consideration l. Then

$$\text{Power spent in core} = l\,x^2\,(4\,z + 2\,x) = 4\,l\,x^2\,z + 2\,l\,x^3.$$

The loss in a cubic centimetre of copper varies as the square of the current density. The most economical current density ought, properly speaking, to be determined by taking the current density as a variable; but it is generally so high that the coils would get hot. At first sight it may seem strange that a piece of apparatus that gets hot can be more efficient than one that keeps cool; but it must be remembered that the temperature depends on the facility for dissipating the heat, and a large transformer can lose more heat by radiation and convection than a small one, and can thus keep cool, though less efficient. Similarly a dynamo that gets hot is not necessarily inefficient. Heating is inadmissible on the score of durability and safety, so a current density must be assumed that will not cause excessive rise of temperature. The current density can generally be settled beforehand, as the size of the coils will be roughly known, and a safe density can be taken. If the loss per cubic centimetre of copper, with a current density of one ampere per square centimetre, is called p, the loss per cubic centimetre of copper is $p\,d^2$, d being the density in amperes per square centimetre. As the output is known, and the current density is assumed, and the thickness of insulation is also known, the proportion of copper to the whole volume of the coil is known. Call this k.

The loss in the copper is then $k\,z^2\,p\,d^2\,(4\,x + 4\,z)$, so the total loss in the transformer is

$$4\,l\,x^2\,z + 2\,l\,x^3 + 4\,k\,p\,d^2\,x\,z^2 + 4\,k\,p\,d^2\,z^3.$$

In this expression the extra loss of power due to the magnetising current in the primary coil is neglected, as it is exceedingly small. The magnetising current is itself small, and differs in phase, roughly, a quarter of a period. Thus, if the magnetising current were even 10 per cent. of the full load current, the full load loss in copper would only be about 1 per cent. more than here allowed. If B_v is the virtual induction in the core, and n the vibrations per second, $4\,B_v\,n \times 10^{-8}\,x^2$ is the electromotive force per turn of primary or of secondary wire. The total electromotive force is $4\,B_v\,n\,x^2 \times 10^{-8}$ multiplied by the number of turns in the primary or secondary coil. The output of both coils, or twice the output of the transformer, or $2\,P = 4\,B_v\,n\,x^2 \times 10^{-8}$ multiplied by the ampere turns in both coils. The ampere turns $= k\,d\,z^2$, so that

$$2\,P = B_v\,n \times 10^{-8} \times k\,d\,x^2\,z^2;$$

$$\text{therefore} \qquad z = \frac{1}{x}\sqrt{\frac{2\,P}{4\,B_v\,n\,10^{-8}\,k\,d}},$$

Call the coefficient b, then $z = \frac{b}{x}$

The total loss is thus

$$4\,l\,b\,x + 2\,l\,x^3 + \frac{4\,k\,p\,d^2\,b^2}{x} + \frac{4\,k\,p\,d^2\,b^3}{x^3},$$

$$\text{so that} \qquad 4\,l\,b + 6\,l\,x^2 - \frac{4\,k\,p\,d^2\,b^2}{x^2} - \frac{12\,k\,p\,d^2\,b^3}{x^4} = 0;$$

$$\text{or} \qquad 3\,l\,x^6 + 2\,l\,b\,x^4 - 2\,k\,p\,d^2\,b^2\,x^2 = 6\,k\,p\,d^2\,b^3.$$

This can be solved as a cubic equation for each transformer wanted, or by trial. In practical work an exact solution of such an equation is not required, as any dimensions that even approximately fit the equation give sensibly the same efficiency. Thus x can be made a round number of millimetres, or of eighths of an inch. If a complete table of transformers is wanted it may be shorter to make a finite difference table increasing x^2, the cross-sectional area of the core by jumps of, say, two square centimetres. Or the table may be calculated directly with the aid of a slide rule. In practical work a great deal of time may be wasted, not on legitimate calculations, but on work containing clerical errors, and on trying to find out the mistakes and to see how they got there. Any one who is an inaccurate worker may therefore prefer to make a table in such a way that if the last term is right all the rest must be right too.

A complete set of closed circuit transformers was designed by me for Messrs. Crompton and Co., the waste in copper and in iron and the cost of material and the efficiencies under various circumstances being worked out. In this case the loss in iron was assumed to be about half as much again as in this Paper, as that seemed a fair margin for practical work, though it might not be assumed for argumentative purposes. Most of them were calculated for a frequency of only 33 per second; as I found that led to great saving in the manufacture of the dynamo, and led to small extra cost and loss of efficiency in the transformers, some of these tables may be shortly discussed before going farther. The induction is taken at 14,000, and the loss is taken at 14,600 ergs per cubic centimetre per cycle, or ·024 joules per cubic inch.

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TABLE I.—24 hours. 2,000 p. per minute. $l = 8$.

Lamps.	P. w.	S. w.	k.	b.	x.	z.	Power.		Efficiency.	c. d.	Cost.	
							Iron.	Copper.			Iron.	Copper.
2	·0087	·039	·262	2·76	1·325	1·92	14·5	8·75	84	1000	1·25	3
5	·00138	·0617	·4	3·54	1·64	2·15	25·6	19·7	87·5	„	2·25	6·75
10	·0195	·0875	·5	4·47	1·95	2·3	39·7	28	89	„	3·45	9·6
25	·0309	·138	·295	9·2	2·5	3·68	100	70	90	„	8·7	24
35	·0365	·164	·333	10·5	2·75	3·75	124	83·5	90·5	„	10·6	33
50	·0437	·196	·375	11·5	3	3·84	154	103	92	„	13·4	35
70	·0517	·231	·41	13	3·22	4·05	188	137	92·8	„	16·4	47
100	·062	·245†	·49	14·3	3·5	4·07	225	170	94	„	19.6	59
160	·078	·32†	·54	17·2	4·9	4.43	303	250	94·5	„	26·3	86
250	·0975	·387†	·6	2 ·4	4·4	4·62	423	325	95	„	37	112
400	·1235	·49†	·65	21·8	4·9	4·78	645	420	95·5	„	56·5	144
650	·157	·624†	·69	30·8	5·5	5·5	700	660	96·5	„	61	227
1000	·195	·774†	·73	37	6·125	6·07	1095	920	96·75	„	95	315

TABLE II.—16 hours. 2,000 periods per minute.

2	·0071	·032	·25	2·31	1·3	1·78	19·7	15·4	77·5	1500	1·14	2·3
5	·0126	·0566	·38	3·3	1·57	2·1	34	35·5	31·25	1200	2·	7·3
10	·0179	·08	·46	3·8	1·77	2·15	46	49	86·4	„	2·67	14
25	·0309	·138	·295	9·2	2·3	4·03	132	84	87·5	1000	7·7	28·7
35	·0365	·164	·333	10·5	2·55	4·12	168	102	88·5	„	9·8	35
50	·0437	·195	·375	11·5	2·7	4·27	198	133	90	„	11·5	45·7
70	·0517	·231	·41	13	2·95	4·4	345	183	90·7	„	14·2	62·5
100	·062	·245†	·49	14·3	3·05	4·84	285	253	92	„	16·5	86

TABLE III.—8 hours. 2,000 periods per minute.

2	·00945	·0425	·317	2·72	1	2·72	21·3	17·8	75·5	850	·62	8·4
5	·015	·067	·424	3·72	1·265	2·84	55	28·5	78·4	„	1·6	13·5
10	·0212	·0945	·5	4·6	1·48	3·15	82·5	46·3	82·4	„	2·4	22
25	·0334	·15	·295	10	1·9	5·17	213	108	82·5	„	6·2	51
35	·0396	·177	·35	11·8	2·2	5·35	300	172	85	„	8·7	83
50	·0475	·212	·395	12·2	2·3	5·3	330	170	85·7	„	9·6	80
70	·056	·222†	·47	13·5	2·45	5·5	385	230	87·3	„	11·2	109
100	·067	·266†	·51	15·2	2·8	5·4	515	245	89	„	15	116

TABLE IV.—4 hours. 2,000 periods per minute.

10	·0225	·1	·55	4·9	1·26	3·9	163	68	72·25	750	2·3	61·5
25	·0355	·159	·33	10	1·6	6·25	347	160	75	„	5	97·5
35	·0425	·189	·36	11·36	1·7	6·65	416	209	78	„	6	128
50	·0503	·225	·41	12·75	1·9	6·7	532	250	79·5	„	7·7	153
70	·0595	·264†	·45	14·4	2·05	7	630	313	81·7	„	9·2	190
100	·071	·318†	·5	16·3	2·22	7·8	720	480	83	„	10·4	293

TABLE V.—2 hours. 2,000 periods per minute.

10	·0225	·1	·55	4·9	1·1	4·45	232	95	65	750	1·7	58
25	·0355	·159	·33	10	1·35	7·4	566	250	65	„	4·1	153
35	·0425	·189	·36	11·36	1·48	7·7	705	305	67·6	„	5·1	186
50	·0503	·225	·41	12·75	1·61	7·95	870	390	70·5	„	6·1	239
70	·0595	·264†	·45	14·4	1·8	8	1100	440	73·2	„	8	269
100	·071	·318†	·5	16·3	1·9	8·6	1310	610	76	„	9·6	373

TABLE VI.—1 hour. 2,000 periods per minute.

10	·0225	·1	·55	4·9	·91	5·4	370	160	53	750	1·35	97·5
25	·0356	·159	·33	10	1·15	8·7	930	385	53·2	„	3·4	235
35	·0425	·189	·36	11·36	1·25	9·1	1160	500	55·4	„	4·25	305
50	·0503	·225	·41	12·75	1·375	9·25	1450	587	60	„	53	360
70	·0595	·264†	·45	14·4	1·49	9·65	1760	750	62·5	„	6·4	460
100	·071	·318†	·5	16·3	1·62	10	2162	920	66	„	7·8	560

TABLE VII.—50-Lamp Transformer. 1,000 and 50 volts. 2,000 periods per minute.

P.w.	S.w.	c. d.	Time.	k.	b.	x.	z.	Power.		Efficiency.	Efficiency at 2000 to 100.	Cost.	
								Iron.	Copper.			Iron.	Copper.
·062	·245†	1000	24	·49	10·1	2·92	3·46	135	104	92·6	9·2	11·7	35·7
„	„	„	16	·49	„	2·67	3·8	176	128	90·6	90	10·2	44
·067	·266†	850	8	·51	10·75	2·25	4·76	286	202	86	85·7	8·4	100
·071	·28†	750	4	·53	11·2	1·85	6·05	460	240	81	79·5	6·7	146
·071	·318†	„	2	·53	„	1·59	7	750	535	73	70·5	5·5	213
„	„	„	1	·53	„	1·36	8·2	1260	535	62·6	60	4·6	325

TABLE VIII.—50-Light Transformers under various Time Loads. 2,000 periods per minute.

Time.	Power.	24		16		8		4		2		1	
	Copper.	P iron.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.	P. I.	Efficiency.
24	103	154	92	230	90	460	84·2	920	74·5	1840	60·6	3680	44·2
16	133	133	91·8	198	90·5	396	85	792	76·5	1580	63·7	3168	47·6
8	170	110	91·4	165	89·7	330	85·7	660	78·4	1320	68	2640	51·7
4	250	89	89·9	133	88·6	266	85·4	532	79·5	1064	69	2128	55·6
2	390	72	87·6	108	85·9	217	83·3	435	78·5	870	70·5	1740	58·5
1	587	60	82·3	90·6	81·6	181	79·8	362	76	725	69·6	1450	60

TABLE X.—5,000 periods per minute.

Lamps.	P. w.	S. w.	Hours.	k.	b.	x.	z.	Power.		Efficiency.	Cost.	
								Iron.	Copper.		Iron.	Copper.
1,000	·195	·774†	24	·73	23·4	4	5·86	1000	690	97·2	35	237
50	·0473	·195	„	·375	7·3	1·925	3·8	141	83	93	5	28·6
50	·0503	·225	1	·41	8·1	·875	9·25	1440	420	62	2·6	257

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TABLE IX.—Fall of Secondary E.M.F. 2,000 periods per minute.

Lamps.	Hours.	16	8	4	2	1	24 1
...	24						
2	6·75	12·85	14·85	...	...	...	with 5,000
5	6·5	11·8	9·5	...	...	...	p. per min.
10	4·65	8·3	7·7	11·3	15·8	26·6	
25	4·65	5·6	7·2	10·65	17·75	25·6	
35	3·9	4·95	8·3	10	14·5	23·7	...
50	3·42	4·35	5·65	8·3	13	19·5	2·76 14
50*	3·46	4·25	6·7	8·	11·8	17·8	
70	3·25	4·35	5·5	7·5	10·5	17·8	
100	2·83	4·2	4·07	8	10·2	15·3	
160	2·5						
250	2·1						
400	1·8						
650	1·6						
1,000	1·5						1·15

* This line at 1,000 to 50 volts.

The tables were calculated with the object of being useful, so the dimensions are in inches.

In Table I. the first column gives the number of 60-watt lamps. The second and third give the diameter or size of wire in inches in the primary and secondary coils. The dagger means that the wire is square. The fourth and fifth give k and b, which are mere coefficients as before. The column x gives the side of the core, and z the side of the coil in inches. The next columns give the loss of power in watts, The cost of material in the last columns is in shillings, taking iron at 3d. and copper at 9d. a pound. Table I. is calculated for transformers on full load the whole 24 hours.

It must be borne in mind that these tables do not give sizes for actual transformers, but act as guides to give the dimensions that should be approached.

Table II. is calculated for 16 hours a day. This is to say, the transformer is supposed to have the secondary open a third of the time. The transformers have then to be re-designed, as the loss in iron becomes relatively more important. It will be noticed that the efficiency begins to fall off and the price to go up. If transformers from Table I. were used only 16 hours a day, the efficiencies would be lower than those in Table II. Tables III. to VI. need no further explanation. It is well to point out that a great deal depends on the way the time is estimated. Full load one hour a day is not the same as half load two hours a day. Half load two hours a day would have less copper waste, so to make the best transformer the copper would be increased and the iron lessened. These last transformers are really absurdities: the 50 lights in Table VI. has an average efficiency of only 60 per cent., and costs about £20 for material only. The E.M.F. has so far been assumed to depend only on the induction in the iron core, but when the core is so small and the coils are so large this is no longer even approximately true, as will be explained later.

Table VII. is to show what may be gained by transforming from 1,000 to 50 volts instead of from 2,000 to 100. The difference is due to the difference of room taken up by the insulation. The table is made for 50-light transformers, designed for the various times of full load. The column of efficiencies at 2,000 and 100 volts is for transformers designed for these volts, not for the same transformers merely re-wound. The difference would be greater if the same transformer were used in each case. It will be seen that the efficiencies and costs are very little reduced by using low tensions; but as the percentage fall of E.M.F. on the lamps is increased by using the most efficient transformer, it would be best not to design the low tension transformer with a view to efficiency only.

Table VIII. shows the effect of using transformers for time loads for which they are not intended. Thus a full time 50-light transformer has an efficiency of 92 per cent. on full time, but only 44·2 per cent. with full load an hour a day. The 50-lighter, specially designed for one hour a day, has an efficiency of 60 per cent., but at 24 hours a day it only rises to 82·3 per cent. The fall of E.M.F. on the lamps is also quite out of the question.

Table IX. shows the percentage fall of secondary E.M.F. at full load. The Table, like those before it, is for a frequency of 33. The last two columns show the advantage of using 80 per second. The loss in a 50-lighter is 2·76 instead of 3·42 per cent. in the case of 24 hours, and 14 per cent. instead of 19·5 for the 1-hour transformer. The 1,000-lighter would be for substations, and would never have its primary on and its secondary off, so it is taken for 24 hours only. The fall is 1·5 per cent. at 33, at 1·15 at 80.

It is needless to remark that when the variation of terminal E.M.F. is great, it is very much more important than the efficiency of the transformer itself as it affects the efficiency of the lamps, and thus of the whole system.

Table X. is for three transformers for a frequency of 80. The 1,000-lighter has an efficiency of 97·2 instead of 96·75, or an increase of ·45 per cent. Its cost of material is £13. 10s., instead of £20. 10s.

The efficiency of the full time 50-lighter is 93 against 92, and its cost of material is £1. 13s. 6d., against £2. 8s. 6d. This must, of course, not be confused with the cost of the transformer, which includes many other items.

(To be continued.)

A NEW THERMOMETRIC SCALE.*

BY PROF. G. FORBES AND W. PREECE, F.R.S.

The recent Electrical Congress at Paris has adopted the *Joule* as the unit of work and the *Watt* as the unit of power. The following definitions were unanimously accepted:—The practical unit of work is the *Joule*. It is equal to 10^7 C.-G.-S. units of work. It is the energy expended during one second by an ampere in an ohm. The practical unit of power is the *Watt*. It is equal to 10^7 C.-G.-S. units of power. The watt is equal to a joule per second.

The *therm* as the unit of heat, which was proposed by the British Association Committee, at Bath, last year, did not commend itself to the French members. They preferred for the present to retain the term *calorie*, notwithstanding the confusion from their being two units of that name. It is said there is only one calorie in the C.-G. S. Centigrade system. But the question arose, is there any need for either the therm or the calorie? Cannot the joule be made the thermal unit also, for the latter is only a unit of work? The heat generated in T seconds by C amperes flowiug through R ohms, or driven by E volts, is $C R T = E C T$ joules. If we take the mechanical equivalent of heat as approximately 42,140,000 ergs, or 4·2 joules, it means that 4·2 joules will raise one gramme of pure water at 4°C. one degree; or, in other words, that one joule expended on one gramme of pure water will raise its temperature ·238°C.

We have here the true scientific mode of forming a C.-G.-S. thermometric scale. If we take the fiducial points of freezing and boiling points of pure water at normal pressure on a column of mercury as usual, and divide the distance into 420 divisions, then each division is a true C.-G.-S. unit of temperature, and will be passed by the expenditure of one joule per gramme of water. Instead of employing degrees of temperature we can thus use these units of temperature, and we can replace the angular symbol x° by t or θ.

Thus to raise one gramme of water from freezing point to boiling point requires 420 joules, or to raise it to boiling point from 62 units it requires 358 joules. There would be no necessity for any coefficients, and calculations would be simplified.

Degrees Centigrade would be simply converted into three units by multiplying by 4·2, and degrees Fahrenheit by deducting 32 degrees and multiplying the remainder by 2·33. An objection to such a scheme has been raised by Prof. POTIER, of Paris, and it is that the mechanical equivalent of heat has not yet been determined with sufficient accuracy to justify its adoption as final. He thinks it wrong by nearly 1 per cent. The principal measurements are—

Joule (1878)	4·1624	Violle	4·2701
Hern	4·2485	Regnault	4·2877

This ought to be a reason to re-examine the question, and with our existing knowledge of the ohm and the ampere we ought to be able to derive the joule with an exactitude that will satisfy the scientific world.

* Paper read before the British Association in Section A, Newcastle-on-Tyne, September, 1889.

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SOME ELECTRICAL PAPERS IN SECTION G.

The wide extent as well as the singular diversity of parts which, in the drama of modern civilisation, electricity is called upon to play, was well illustrated by the series of papers which were read on Monday last in Section G. before the British Association. For the lighting of our streets and houses, for the purification of our sewage, for the transmission of articulate speech betwixt city and city, or for the propulsion of tramcars or river launches, it is to electricity that we now turn as affording an appropriate solution. It is worthy, perhaps, of note that the reasons why we find it advantageous to call electricity to our aid are almost as diverse as the purposes to which it is applied. Sometimes, as in telegraphs and telephones, there is practically no other agent to which the duty can be entrusted; sometimes we employ electricity because, if more costly, it does the work in an incomparably better manner; in other cases it is because it is the cheapest, whilst in others it is the most rapid or the most efficient means at our disposal. Those who have closely watched the recent developments of the industrial applications of electricity can scarcely doubt that we are approaching a period in which its special modes of utilisation, apart from the great departments of electric lighting and the transmission of energy, will undergo an extension of which at present we have perhaps little conception. The electrical refining of sugar, as presented by FRIEND and Co., was a palpable fraud, which ought never to have deceived the merest tyro in electro-chemistry; but the case is very different when we come to such operations as the purification of sewage, the method of electric bleaching, the electric welding and refining

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of metals, the separation of aluminium, the modern methods of plating with platinum, cobalt, and other costly metals, and to this we may perhaps add the application to the tanning of hides. All these processes, and many others which might have been included, important and diversified as they are, form probably but a mere fraction of the special applications of the electric current in our arts and manufactures, of which we may within a comparatively short period witness the introduction. As soon as the extension of central station lighting has familiarised the public mind with the presence of electricity, and has rendered it generally available, we anticipate a considerable impetus to its employment, by the discovery of channels for its utilisation which may not hitherto have seemed worthy of investigation.

For this reason, amongst others, we think it a matter for congratulation that the seven electrical papers in Section G., although, with one exception, they afforded but little novelty for electricians, have yet admirably served the purpose of bringing before the public mind some of the most striking and most important instances of the modern applications of electricity. To the remark that novelty was lacking, there is, however, one important exception which must necessarily be made. Had we heard from Mr. SWINBURNE a Paper which did not contain, at the very least, one startling and suggestive novelty, it would have been—well, a startling novelty in itself. Mr. SWINBURNE'S Paper on Transformers deserves the most thorough and attentive consideration, for, if he be right, there is not a single transformer now in the market which is constructed in accordance with sound economic and scientific principles. Whatever may be the actual value of Mr. SWINBURNE'S revolutionary proposal to return to the open-magnetic-circuit type — and on this we do not at present express an opinion—it is, at least, certain that to design a transformer with a view solely to obtaining maximum efficiency at maximum load is, *as a rule*, totally wrong. A moment's consideration will, however, show that Mr. SWINBURNE was not quite right in saying that this method of design is *always* wrong. Transformers must, in fact, be designed with direct reference to the class of work which they will be called upon to do. For shop lighting, for instance, we should in general aim at getting maximum efficiency with maximum load, whilst for private houses about one-third load is probably the point at which the efficiency may with advantage be highest. To use one type of transformer for all conditions is an obvious error. The result of Mr. SWINBURNE'S research, on the most economical proportions of iron and copper, has been to lead him, as already hinted, to return to the open magnetic circuit; by this device he, of course, saves much of the energy now lost in hysteresis, but he is obliged at the same time to diminish the section of the iron and increase the quantity of copper in order to retain the magnetising current within economical limits. Whether this is or is not the best method of diminishing the waste of power in the primary circuit when the secondary circuit is unclosed, is as yet an open question. The question is one which is already attracting serious attention, and some very different solutions are being attempted. At Zurich, for instance, where Messrs. BROWN, of Oerlikon, are putting down a central station with "Kapp" alternating plant, the houses are supplied from a limited number of sub-distributing stations. Each of these stations contains two transformers of different sizes, one for the day and the other for the night service. Another solution which must often have occurred to those engaged in this work is that of arranging some device whereby the primary coil is only brought into circuit at the moment when the secondary is closed, and is again switched out when the last lamp is turned off. The problem is not quite an easy one, but it can doubtless be solved in some way, and, indeed, we understand that the London Electricity Supply Company are now experimenting in this particular direction. Of course if, as is very possible, Mr. SWINBURNE'S solution be the right one, we shall be spared the trouble of any such supplementary devices or the expense of extending the secondary circuits to the distributing mains.

The mention of supplementary devices naturally brings to our recollection the important Paper read by Major-General WEBBER on the installation at Chelsea, and which installation at first sight seems to be one grand collocation of supplementary devices. We do not, however, say this by way of reproach, for of one thing there can be no doubt, and that is that the automatic appliances designed by the staff of the Electrical Power Storage Company discharge their duties with the most praiseworthy accuracy and efficiency. Nearly two years ago we witnessed at Millwall the working of the first set of automatic switches designed for this purpose, and constant experiment and experience since that date has enabled Mr. F. KING and his colleagues to bring the design to a state of perfection which is really marvellous. Complex and elaborate it undoubtedly is, and apparently so it must always be if it is to fulfil the required conditions, but if this be entered as a serious objection to the system, there remains still one redeeming feature, namely, that (according to the inventors) no possible breakdown in the automatic mechanism can result in any even partial breakdown of either the generating or the discharging circuits.

We had meant to say a few words upon the interesting Papers of Prof. FORBES, and Messrs. PREECE, MANVILLE and WEBBER, but space does not permit, and we must conclude by repeating that, in spite of their comparative want of novelty, nothing but good can result from the reading of Papers of this class before the British Association.

REVIEWS.

The A. B. C. of Electricity By W. H. MEADOWCROFT. (Manchester: Heywood, 1889.)

This is a little book of 108 pages in a somewhat prettily executed cover, illustrating a group of incandescent lamps and a dynamo supplying them with current, and bearing underneath the pictorial design the magic inscription, "Endorsed by Thomas A. Edison."

On opening the book we find that it is well-printed, on very good paper, and we find, moreover, a letter from Mr. Edison in which he states that he has read the MS. of Mr. Meadowcroft's work and finds that the statements which he has made in it are correct, from which we conclude that the inscription printed on the cover applies to the contents of the book, and not, as might be supposed, to the design below which it is placed.

We are informed in the preface that the volume has had an extensive circulation in America, and that it is intended to give to young people of the age of fourteen years and upwards a general outline of the science of electricity together with some idea of the telegraph, the telephone, and electric lighting.

When we look beyond the preface we find that the language in which the book is written is such as might be adopted in this country in addressing children of from six to eight years of age, and which would, we fear, be resented by English schoolboys or school-girls, of the age of fourteen or even less, and we hardly think that even Mr. Edison's endorsement would be sufficient to reconcile them to it. It may, however, be different in the States, where we understand it is generally believed by the uninstructed that Mr. Edison is the inventor of electric lightning, of the telephone, and possibly even of the telegraph, if, indeed, he was not the discoverer of electricity itself. Mr. Edison's endorsement may therefore very possibly have led

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many young people in the States to peruse the book with eagerness and to imbibe with implicit confidence the statements vouched for by so great an authority. For our own part we do not look for profound scientific knowledge from that very ingenious inventor, but we own that we were surprised to meet, in a book which may to a certain extent be regarded as his profession of electrical faith, with a statement such as the following, which we quote from the second page of the text: "We all know that if you have a pound of water you must have something to hold it because it has weight and consequently occupies some space. But electricity itself has no weight and therefore cannot occupy any space." We do not ourselves see the cogency of this reasoning. Put into the form of a logical proposition it stands thus—

Everything that has weight occupies space.
Electricity has not got weight;
Therefore, electricity does not occupy space.

An exactly similar argument would be the following:—
All men are mortal.
Horses are not men;
Therefore, horses are immortal.

On the same page we are told that pressure is reckoned as so many pounds to the square inch of water. We should very much like to know what a square inch of water means; of course, on the assumption that the author is writing for the inhabitants of our ordinary world of three dimensions, and not for the denizens of Flat Land, where everything has two dimensions, so that material bodies are measured in superficial measure. A few pages further on we are told that the pressure in a boiler is measured or calculated in pounds, just as the pressure of water is measured. Here, as before, reference to the square inch is required, although the author does not give it to us, but it should be a square inch of boiler surface, just as in the former case it should have been a square inch of the surface on which the pressure was exerted.

After this we are not surprised to learn that a hundred pounds of steam pressure can be changed to electricity at 100 volts pressure, or that electricity can be turned into heat.

The concluding paragraph on magnetism is worth quoting. "The only way we can get electricity to do useful work for us is to put some resistance or opposition in its way. So you see that if we make it travel through the wire around the iron or steel there is just enough resistance or opposition in its way to give it work to get through the wire, and this work produces the peculiar effect of making the iron or steel magnetic."

It is quite true that electricity will only do work when there is some resistance in its way, that is to say when we give it something to do; but the author is evidently under the impression that the best way to make electricity do work in one direction is to give it a resistance to overcome somewhere else, which is much the same as saying that a man pulling water out of a well by means of a bucket would be assisted in his work if half a hundredweight of lead were fixed to the bottom of the bucket.

A current passing round a piece of iron has to do work in magnetising it, but the work is done in the interior of the iron. The magnetising effect of the current is most decidedly not assisted by increasing the resistance of the wire through which it flows, but, as every electrician knows, is diminished, for the simple reason that when a given E.M.F. is maintained between the ends of a wire the effect of increasing the resistance is to make less current flow through the wire, so that there is a smaller magnetising effect.

The author's practical descriptions are decidedly better than his theory, but even here his explanations are not always satisfactory. For example, he informs his infantile, or other readers, that if the connecting wires were attached directly to the ends of the revolving armature coils, they would be broken off, and that this catastrophe is avoided by the use of a commutator.

We, in our innocence, had always supposed that continuous sliding contacts were used for this purpose, and that the object of a commutator was to rectify the alternations of the current. The author's explanations of the action of the electric current in making a carbon filament incandescent is too good to be omitted:—

"You see it is a struggle between the carbon and the electricity, the current being determined to go on, and the carbon trying to keep it back, and in the end the electricity being the strongest gets the best of it; but the struggle has been so hard that the carbon has been raised to a white heat, and so gives out a beautiful light, which continues as long as the current of electricity flows."

We have not infrequently met with explanations of a very similar character in the papers of examinees striving after the, to them, unattainable prize of a Science and Art Department certificate in the elementary stage of electricity and magnetism.

THE MEETING OF THE BRITISH ASSOCIATION.

The following is a complete list of the electrical Papers read, reports presented, and instruments exhibited at the recent meeting of the British Association:—

SECTION A.

Prof. J. Blyth.—"On a New Form of Current-Weigher."
J. T. Bottomley, F.R.S.—Exhibition of Leyden Jars with Multiple Fracture.
P. Braham.—"The Action of Magnetism on Photographic Plates.
A. W. Clayden.—"On Dark Flashes of Lightning."
Dr. H. E. J. G. du Bois (Communicated by Sir W. Thomson, F.R.S.).—"On Kerr's Magneto-optic Phenomenon: its laws and application for measuring purposes."*
Prof. J. A. Ewing, F.R.S.—"Hysteresis in the Relation of Strain and Stress."
Prof. J. A. Ewing, F.R.S.—"Magnetic Viscosity of Iron."
Prof. G. Forbes, F.R.S., and W. H. Preece, F.R.S.—A New Thermometric Scale.
Dr. J. H. Gladstone, F.R.S., and Dr. W. H. Perkin, F.R.S.—"On the Correspondence between the Molecular Refraction, Dispersion, and Magnetic Rotation of Carbon Compounds."
Prof. Oliver J. Lodge, F.R.S.—"On the Failure of Metal Sheets to Screen off the Electrostatic Effect of Moving or Varying Charges."
Prof. Oliver J. Lodge, F.R.S., and R. T. Glazebrook, F.R.S.—"On the Determination of 'v' by Means of Electric Oscillations."
Magnus Maclean and Makita Goto (communicated by Sir W. Thomson, F.R.S.).—"Electrification of Air by Combustion."
Prof. J. Perry, F.R.S.—Exhibition of Standards of Self-induction.
Prof. J. Perry, F.R.S.—A Twisted-strip Voltameter.
W. H. Preece, F.R.S.—"On the Relative Effects of Steady and Alternate Currents on Different Conductors."
Prof. A. W. Rücker, F.R.S.—"On the Instruments used in the Recent Magnetic Survey of France."
W. N. Shaw.—Report on the Present State of our Knowledge in Electrolysis and Electro-Chemistry.
Prof. A. Shuster, F.R.S.—"On the Discharge of Electricity through Gases."
Prof. C. Michie Smith.—"Notes on Atmospheric Electricity and the Use of Sir W. Thomson's Portable Electrometer."
Prof. H. Stroud.—"On the E.M.F. produced by an abrupt Variation of Temperature at the Point of Contact of Two Portions of the same Metal."
J. Wilson Swan.—"On Chromic Acid as a depolariser in Bunsen's Battery."
Prof. S. P. Thompson.—"On Sparkless Electro-magnets."
Prof. S. P. Thompson.—"On a Phenomenon in the Electro-Chemical Solution of Metals."
F. T. Trouton.—"Some Experiments on Radiation with Prof. Hertz' Mirrors."
Prof. Leonhard Weber.—"On Atmospheric Electricity."
Prof. Leonhard Weber.—"On Photographs of Lightning."
Prof. A. M. Worthington.—"On the Discharge of Electrification by Flames." [Communication to the Electrolysis Committee.]
Report of the Committee on Electrical Standards.
Report of the Committee on Electrolysis.
Report of the Committee on Magnetic Observations.
Report of the Committee on the Magnetisation of Iron.

SECTION B.

J. H. J. Dagger, F.I.C.—"The Manufacture of the Alloys of Aluminium in the Electric Furnace."

* Taken as read, it being announced that the Paper would appear in *The Electrician*.

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SECTION D.

PROF. J. COSSAR EWART.—"On the Modifications of Electric Organs in Elasmobranch Fishes."

PROF. W. A. HERDMAN.—"On the Electric Light as a Means of Attracting Marine Animals."

SECTION G.

PROF. G. FORBES, F.R.S.—"Electric Launches on the Thames."

KILLINGWORTH HEDGES.—"Precautions necessary in the Use of Transformers."

EDWARD MANVILLE.—"Series Electrical Traction (Northfleet Tramways)."

W. H. PREECE, F.R.S.—"Telephonic Communication between London and Paris."

J. SWINBURNE.—"The Design of Transformers."

MAJOR-GENERAL WEBBER.—"The Distribution of Electricity from Accumulators."

W. WEBSTER.—"Electrical Purification of Sewage."

JOINT MEETING WITH SECTION C.

PROFS. A. W. RÜCKER, F.R.S., AND T. E. THORPE, F.R.S.—"On the Relation between the Geological Constitution and the Magnetic State of the United Kingdom."

ON HYSTERESIS IN THE RELATION OF STRAIN TO STRESS.*

BY PROF. J. A. EWING, F.R.S.

It is now well known that when an iron wire is subjected to the alternate application and removal of tensile stress, many times repeated, certain of its qualities which are affected by the changes of stress exhibit hysteresis with regard to the changes of stress. If the load is cyclically varied between definite limits these qualities do not have the same values at corresponding intermediate points during the application and removal of load; there is a hysteresis or lagging in the change of quality which is some cases appear to be of a static character—that is to say, independent of the time-rate of variation of stress. Conspicuous instances of this action are seen in the change of magnetic and thermo-electric qualities under change of stress, some of which have been described by the author in former Papers.

It is natural to look for an effect of the same kind in the extension and retraction which the wire undergoes. We should expect that, after the change of loads has been frequently repeated, so that a cyclic *régime* is established, the wire will, for any value of load intermediate between the two extremes, be longer during unloading than during loading. Evidently, if such an effect exist, it must be small, as it is well known that the proportionality of strain to stress which is expressed by Hooke's law is at least approximately exact. Sir W. Thomson's experiments on the damping of torsional vibrators have long ago shown that an action of the kind spoken of occurs in quickly-performed cycles of torsional strain; but it does not seem to have been looked for in slow cycles of longitudinal pull.

The author has, with the assistance of one of his students, Mr. D. Low, looked for the effect in question, and has found it, not only in iron, but in steel, brass, and copper wires. He has not yet examined other metals.

The experiment consisted in observing, with much optical magnification, the extension of a very long piece of wire, directly loaded with lead weights. The wire was hung from a rigid support in a testing flue or recess, built in the wall of the laboratory, and extending up through four storeys. At a distance of 806 centimetres below the top a small clamp was fixed on the wire, and this formed the support of the back foot of a little tripod, the feet of which consisted of three needle points about an inch apart. The two front feet rested in a slot and hole in a fixed shelf which stood in front of the long wire. The tripod carried a plane mirror which became tilted forward or backward as the wire extended or retracted. Readings were taken by a telescope of the reflected scale of a levelling staff placed vertically at a distance of some 5 metres from the mirror. The staff was graduated to $\frac{1}{100}$th of a foot, and it was easy to read by estimation to $\frac{1}{1000}$th of a foot, which corresponded to 0·000000102 of the length of the wire. At first a fixed shelf was used to support the two front feet of the mirror, but the effects of temperature were found to be excessive, although the greatest care was taken to shield the wire from draughts, and the plan was resorted to of hanging the shelf from two adjacent wires of the same material, suspended from the same support as the wire which was to be stretched. In this form the method of optical multiplication was nearly the same as one used by Mr. Bottomley in recent experiments on the extension of loaded wires by heat.

The first wire tested was of iron, in the hard-drawn state, 1·08 millimetre in diameter. A weight of 14lb. was kept permanently on it, and an additional weight of 20 kilometres was applied and removed many times. Then readings were taken at intermediate loads (the extreme load caused so much tilting of the mirror that readings could not be taken throughout the whole range). At 10 kilometres (the middle of the cycle) on the way up the scale reading was 2,340; with the same weight on the way down it was 2,305. The difference, due to hysteresis, is 35, or 0·00000357 of the length. The whole extension per kilometre was 533 scale divisions, so that the change of length due to the full load of 20 kilometres was $20 \times 533 = 10{,}660$ scale divisions. Hence the amount of difference in length at the middle position or, 10 kilometres, in the loading and unloading processes was $\frac{35}{10660}$, or, say, $\frac{1}{300}$th of the whole extension between the extreme load. Another way of stating the result would be to say that the extension had the same value at 10·066 while the load was being increased as it had at 10 kilometres while the load was being diminished; the effect of hysteresis is equivalent to a difference of 66 grammes in the load.

Further experiments were made to test how far this hysteresis depends on the time rate of loading and unloading. In the above case, the cycle of load had been performed as quickly as was practicable, the only pauses being at 10 kilometres on the way up and at 10 kilometres on the way down. It was found that even when the pause at 10 kilometres lasted for two hours no distinct change took place in the readings. So far as this experiment showed, the hysteresis is persistent. It appeared, however, that pauses at the extremes of load has the effect of increasing the difference of readings at the middle. In a slowly performed cycle, where a pause of about three minutes was allowed at each step (of two kilometres) in the processes of loading and unloading, the difference of the readings at 10 kilometres was about 50 scale divisions instead of the 35 divisions observed in the former case.

A similar trial was made with mild steel wire, previously annealed and then hardened by the imposition of a load much greater than the load afterwards used in the testing cycle. Here the wire was 0·94 millimetres in diameter. There was, as in a former case, a constant load of 14lb., and the cycle was made by applying and removing 12 kilometres. At six kilometres the readings were 4,695 and 4,726; difference, 31. The extension per kilometre was 750. Hence the hysteresis is $\frac{31}{12 \times 750} = \frac{1}{290}$ of the extension due to the whole load. With long pauses at the middle load the hysteresis appeared to be reduced to 27 scale divisions, or $\frac{1}{333}$ of the whole extension.

Next, a hard wire of high carbon steel was tested, 0·72 millimetres in diameter, by having 14lb. permanently on, and loading and unloading 12 kilometres. At six kilometres the readings were:—"Up" 9,220, creeping to 9,240 in two hours; "down" 9,400, creeping to 9,370 in two hours. Differences, 180 and 130.

The extension for 1 kilometre was 1,290, so that the above differences correspond to $\frac{1}{86}$th and $\frac{1}{119}$th of the whole extension respectively. It is remarkable that the hysteresis is decidedly greater here than in the wires previously tested.

A brass wire 1·08 millimetres in diameter tested in the same way with 12 kilometres gave readings 6,990 and 7,114 at 6 kilometres, difference = 124, which was equivalent to $\frac{1}{107}$th of the whole extension, since the extension for 1 kilometre was 1,100 scale divisions.

With a copper wire 1·15 millimetre in diameter, loaded with 10 kilometres, the readings at 5 kilometres showed a difference of 52 scale divisions, equivalent to $\frac{1}{158}$th of the whole extension

* Paper read before the British Association, in Section A, Newcastle-on-Tyne, September, 1889.

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These experiments make it clear that in conditions of loading such as those they deal with, there is a decided departure from Hooke's law, one effect of which is that some work is done upon the material when it is put through a cycle of stress change. If the relation of strain to stress were represented graphically, the curves would form loops enclosing a certain area. This result has a sufficiently obvious bearing on the conclusions of Wöher with regard to the deteriorating effect of repeated variations of stress.

ELECTRIFICATION OF AIR BY COMBUSTION.*

By MAGNUS MACLEAN, M.A., F.R.S.E., and MAKITA GOTO, of Tokyo, Japan.

About the middle of April last a series of observations was commenced within the Natural Philosophy Class Room and Apparatus Room, the Bute Hall, the University Tower, and various other rooms in the Glasgow University Buildings, under the instructions of Sir William Thomson, for the purpose of endeavouring to find—(1) the state of the air inside a room as regards electrification, (2) the relation between the electrification of air within a building and the atmospheric potential in its neighbourhood outside, and (3) the causes which produce or change the electrification of any given mass of air.

Up to the 3rd of July, 106 such observations were made, and although we drew curves and compared them carefully, no definite relation could be discovered between the electrification of different rooms in the University, or between the electrification of any of the rooms and the external potential. After that date our experiments were chiefly directed to the finding out of the causes which changed the electrification of the air of the room in which we experimented, and we give in the present Paper a summary of the results which we have already obtained. On the 15th of July Sir William Thomson communicated a Paper on "Electrification of Air by Flame" to the Royal Society of Edinburgh, in which the effect of an ordinary paraffin lamp—the only flame we had tried up to that date—is described. From that Paper we quote the following:—

"In one ordinarily unused room (the Physical Apparatus Museum) 31½ feet long by 24 feet broad and about 20 feet high, practically quite free from any sensible disturbance by electric light wires, or by electrical operations being performed in the Laboratory, a remarkable result has been observed within the past fortnight. The electric potential of a water-dropper, having its nozzle at the centre of the room and about 7 feet above the floor, was always found about two volts negative at the commencement of the observations, and always increased to about 9 volts in the course of the first twenty minutes of a series of observations lasting generally forty minutes. During the last

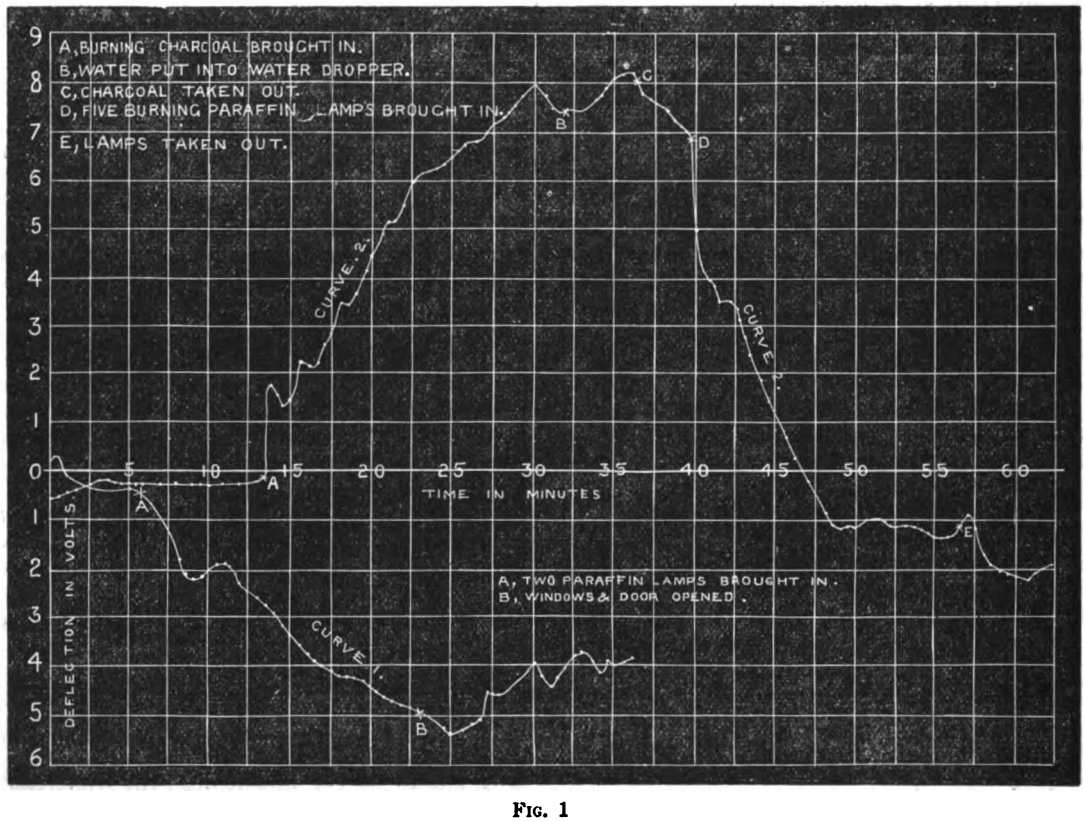
A, BURNING CHARCOAL BROUGHT IN.
B, WATER PUT INTO WATER DROPPER.
C, CHARCOAL TAKEN OUT.
D, FIVE BURNING PARAFFIN LAMPS BROUGHT IN.
E, LAMPS TAKEN OUT.
CURVE 2.
CURVE 1.
TIME IN MINUTES
DEFLECTION IN VOLTS.
A, TWO PARAFFIN LAMPS BROUGHT IN.
B, WINDOWS & DOOR OPENED.

FIG. 1

The method of observation was as follows:—An insulated water-dropper (*see* § 262. Papers on Electrostatics and Magnetism, by Sir W. Thomson) was connected to one of the terminals of a Thomson quadrant electrometer, the other terminal being connected to the case of the instrument and to a gas-pipe for earth. A paraffin lamp and scale were used, and the deflections were read in the usual manner by observing the reflected spot of light.

Two such arrangements were used, one in one room and the other in another room, or both in one and the same room with one water-dropper in the centre of the room and the other discharging out through a window as described in the article quoted above. Readings were taken every half-minute, generally for 30 or 40 minutes, and by comparing watches beforehand it was possible to obtain simultaneous readings of both instruments, however far apart the different rooms were.

twenty minutes of the series the potential remained somewhat nearly constant at 9 volts. Within the room, two quadrant electromoters, each with an ordinary paraffin lamp and scale, were used, one of them for the outside water-dropper and the other for the water-dropper within the room.

"Towards ascertaining the cause of this change an observation was made on the 4th July, between 10 and 11 a.m. The lamps were both extinguished, and one of them was lighted by a lucifer match every five minutes for the purpose of reading the electrometer deflection. It was found that in these circumstances there was not the increase of negative potential which had been found in every previous series of observations in the same place, and with all other circumstances the same except the burning of the lamp. This single observation seemed to prove conclusively that the burning of the lamp gave a negative charge to the air of the room."

Arrangements were made after this to place the electrometer and its lamp outside the room, and observations made, with no

* Paper read before the British Association in Section A, Newcastle-on-Tyne, September, 1889.

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lamp burning inside, or with one or more lamps burning inside. A large number of experiments has fully confirmed the result stated above.

Curve No. 1. (Fig. 1) is one of many which will serve to show the effect. The observation was made on the afternoon of the 9th of August in the English Literature Class-room, which is on the ground floor of the University. It is 37ft. by 34ft. and 24ft. high. The curve shows that as soon as the windows were opened the negative electrification began to be diminished, a change which was due, no doubt, to the coming in of the external air.

After this date the paraffin lamp was dispensed with, and a telescope was used to observe the deflections of the electrometer needle by the mirror attached to it. In all subsequent experiments, water-dropper, electrometer, and telescope are in the same room, as it was found that the effect of one or two persons in the room was practically nothing. The observations were made as follows:—The water-dropper having been filled and allowed to run, the variations of the electrometer needle were observed by the telescope for five or ten minutes. Then the burning substances were placed generally on the floor below the nozzle of the water-dropper, which is 7ft. above the floor, but sometimes in other parts of the room, and the observation continued for ten, twenty or thirty minutes.

The following is a list of various kinds of flames and fires which were tried:—Charcoal, paraffin lamp, coal gas, alcohol; coal both smoking and smokeless; lucifer match wood, ordinary paper (either with a flame or glowing); sulphur, magnesium, phosphorus exposed to air, electrometer match (blotting paper soaked with nitrate of lead). The first four in the list are arranged in the order of magnitude of their effect. With the exception of charcoal, alcohol, the smokeless coal, and glowing wood or paper, the effect of the other substances was distinctly to electrify the air of a room negatively. Alcohol and the smokeless coal have a doubtful effect. Burning charcoal electrifies the air of a room positively, and it does so quickly and largely. Curve No. 2 (Fig. 1) will show the effect. It was obtained in the Physical Apparatus Museum Room on the 23rd of August, and illustrates the effect not only of burning charcoal but of a burning paraffin lamp.

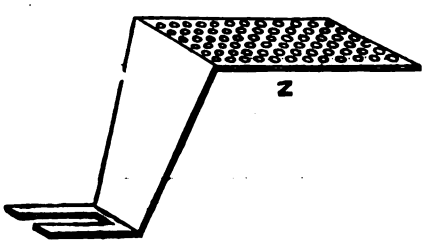

Fig. 2.

A number of observations of this nature satisfied us as to the effect of each burning substance on an enclosed mass of air. We reasoned that if a burning substance electrifies the air negatively, the substance itself must become positively electrified, and we devised the arrangement described below for testing this conclusion.

A strip of sheet copper about 3 centimetres wide and 7 centimetres long is bent into the form of a Z (Fig. 2). The lower end of the Z is joined to one of the terminals of the electrometer (Fig. 3), and the burning substance, or small copper lamp in which the substance burns, is placed on the upper end, which is perforated. The cylinder A, 25 centimetres long and 12 centimetres in diameter, also made of sheet copper, is joined by wire to the case of the electrometer, while it is made to surround, but not to touch, the Z piece with the burning substance placed on it.

Observations were made (1) when the cylinder is not surrounding the Z, and (2) when the cylinder is surrounding the Z. The results obtained when the cylinder is not surrounding the Z, though consistent as regards the sign of the electrification, are not consistent in the magnitude of the electrification obtained. It depends on the state of electrification of the air of the room at the time. For example, when by means of the water-dropper in the usual way the potential of the air of the room was found to be $1\frac{1}{2}$ volts negative, a burning paraffin lamp placed on the Z gave $\frac{1}{2}$ volt-positive, but when the water-dropper indicated that the potential of the air at its nozzle was 3 volts positive air, the paraffin lamp on the Z gave $1\frac{1}{2}$ volts positive. The results obtained with the copper cylinder surrounding the Z are, however, consistent in both these respects. For convenience of reference they are put in the following tabulated form:—

Substances.	Electrification.	Magnitude of electrification with the cylinder.
Charcoal	Negative	3 volts
Paraffin lamp	Positive	$\frac{1}{2}$ „
Alcohol lamp	„	$\frac{1}{3}$ to $\frac{1}{10}$ volt
Phosphorus exposed to air...	„	$1\frac{1}{2}$ volts
Sulphur	„	Variable, 1 to 2 volts
Magnesium	„	—
Lucifer match, wood, paper, burning with flame.....	„	—
The same, glowing.....	Negative	Same as charcoal
Electrometer match, glowing	Positive	Very variable
Blotting paper soaked with sulphate of copper, glowing.....	Positive or negative	Variable

The effect of an ordinary lucifer match is very interesting. While the match is burning with a flame the deflection indicates positive electrification, but after the flame ceases the electrification becomes negative, the effect now being that of glowing charcoal. The room in which all these last experiments have been carried on is a small room at the back of the Law Class Room, which is in the east quadrangle of the University and on the ground floor. It is 8ft. by 10ft., and 24ft. high. It was chosen because it is far removed from electric light* and telephone wires.

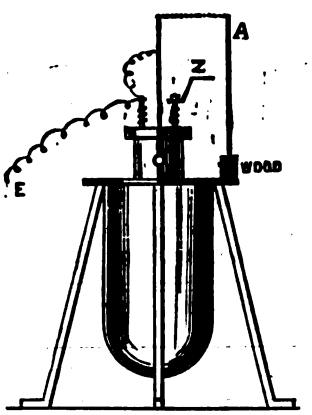

Fig. 3.

Preparations are now being made to test other burning substances in a similar manner, and to try these, as well as those we have already tried, under different conditions.

It is also intended to carry on the observations on natural atmospheric electricity, and to compare with the May and June results, which are not published as yet, because in all the observations a paraffin lamp was always used.

*The effect of the electric light wiring was tried on 24th April in the Natural Philosophy Class Room. The electrometer and water-dropper were set up on the Class Room table, and when the reading indicated about 4 volts negative, the negative lead of Sir William Thomson's house electric-light circuit, which passes through the Class Room, was joined to earth. This changed the deflection of the electrometer by 1 volt in the positive direction. When the positive lead was earthed, the deflection was changed by 6 volts in the negative direction. Putting on 16 electric lamps, eight on either side of the Class Room, changed the deflection by $\frac{3}{4}$ volts in the negative direction.

The Electric Railway on Ryde Pier.—The electric railway on Ryde Pier has proved such a decided success, that one line of rails is utterly inadequate to provide for the traffic. The company have therefore determined to lay down another line next year, and also to further improve the pier.

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ON THE RELATIVE EFFECTS OF STEADY AND ALTERNATE CURRENTS ON DIFFERENT CONDUCTORS.*

BY WILLIAM HENRY PREECE, F.R.S.

1. Sir William Thomson, at the Bath meeting of the British Association, startled the electrical world by asserting that alternate currents entered a distance of only about three millimetres into the heart of a thick, round, copper conductor when the frequency was 150. This "Diffusion Law," as he called it, is based on the assumption that a current starts at the surface of the conductor and works its way radially inwards. It is dependent on the coefficient of self-induction and on the frequency—that is, on the number of complete alternations of positive and negative currents transmitted per second.

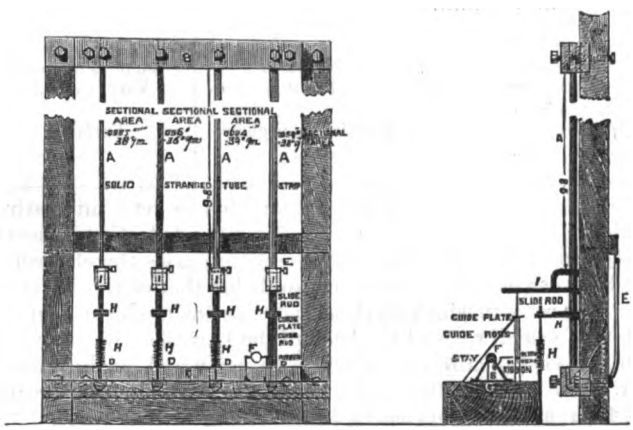

FIG. 1.

2. As this law has a most important bearing on the commercial value of systems of distribution dependent on alternate currents, it becomes most desirable to study the question practically. The verification of the law is almost beyond the reach of experiment. It occurred to me, however, that if we took conductors of different materials, such as iron, copper, lead, and platinoid, of easily measurable lengths and of convenient sectional areas, and transmitted through them measurable and variable currents, both alternate and direct, approximately similar to those used in practice, we should be able to study the question by observing the changes of temperature in the conductors, and we should at least observe any difference, if such existed, in the total expenditure of energy in the conductors under these different circumstances. Any addition or diminution of energy expended would give some indication of the operation of the law of diffusion in comparatively small conductors, without, however, determining the actual distribution of current density.

3. The Eastbourne Electric Light Company placed their machinery at my disposal. Messrs. Bolton and Son supplied me with copper, Messrs. Frederick Smith and Co. with iron, Messrs. John Fowler and Co. with lead, the London Electric Wire Company with platinoid, and Messrs. Elwell, Parker and Co. with accumulators and a specially-made converter. I was fortunate in securing the assistance of Mr. Lowrie, the engineer to the Electric Light Company, and of Mr. Gay, the assistant engineer, who constructed the apparatus and took and recorded the observations. The experiments were very numerous, very costly, and extended over a long period.

4. An extremely strong wooden frame (Fig. 1) was constructed, with a stout crossbar of iron at the top, B, which not only rigidly fixed one end of the conductors, A, to be tested, but also formed a terminal block for the currents. The lower end of the conductor dipped freely into an iron well, D, which could be filled with mercury at will by means of the tubes E, and acted as the other terminal. Stirrups and springs, H, were fixed so as to prevent the buckling of the conductors to be tested. A length of 9ft. 8in. (294·6 centimetres) was accurately marked off each rod, and a clamp, I, was fixed on to the conductor so as to transmit the expansion of the rod to the mirror apparatus F, which could be slid under each rod as it was tested. The construction of this mirror arrangement is more fully shown in Fig. 2. The mirror was deflected by the down thrust of the clamp on the rod, so that a thin metallic ribbon, passing over a pulley on the axis of the mirror, moved it with equal increments in all parts of the scale. A spring, S, brought the mirror back to zero. It reflected a ray of light from the oxyhydrogen lamp H, 20ft. 10in. long (635 centimetres), on to the curved screen N, upon which a scale was drawn such that one inch equalled every one-thousandth of an inch expansion of the conductor A. The scale formed an arc of a circle, having the mirror as its centre.

A.—COPPER.

Material.					Temperature.				Elongation.				Current.					Dynamo.	
Description.	Section.		Length.		Air.		Metal.		Time.		Extreme Elongation.			Time on.	Amp.	Density.		Speed.	Frequency.
	sq. in.	sq. cm.	in.	cm.	F°.	C°.	F°.	C°.	Started.	Stopped.	in.	cm.				sq. in.	sq.cm.		
							maxi	mum.	h. m.	h. m.				min.					
* Round Rod.	·0589	·38	116	294·6	48	8·8	136	57·7	8 2	8 40	·102	·264	Steady	38	200	3395	526	...	...
	·0589	·38	116	294·6	48	8·8	136	57·7	8 42	8 45	·103	·261	Alternating	3	200	3395	526	404	107·73
Tube.	·0604	·39	116	294·6	46	7·7	115	46·1	3 43	4 6	·081	·205	Steady	23	200	3311	513	...	...
	·0604	·39	116	294·6	46	7·7	115	46·1	4 6	4 8	·081	·205	Alternating	2	200	3311	513	404	107·73
Tube.	·0604	·39	116	294·6	43	8·8	118	47·6	6 39	7 0	·0825	·209	Steady	21	200	3311	513	..	...
	·0604	·39	116	294·6	43	3·8	118	47·6	7 0	7 2	·0825	·209	Alternating	2	200	3311	513	404	107·73
† Stranded Cable.	·056	·36	116	294·6	48	8·8	133	56·1	7 16	7 50	·0995	·252	Steady	34	200	3571	555	...	...
	·056	·36	116	294·6	48	8·8	133	56·1	7 50	7 52	·099	·252	Alternating	2	200	3571	555	404	107·73
Flat Rod.	·059	·38	116	294·6	46	7·7	139	59·4	3 6	3 27	·109	·276	Steady	21	200	3390	526	...	...
	·059	·38	116	294·6	46	7·7	136	57·7	3 27	3 30	·105	·266	Alternating	3	200	3390	526	404	107·73
‡ Round Rod.	·0589	·38	116	294·6	58	14·4	149	65·	12 40	1 0	·107	·271	Alternating	20	200	3395	526	577	105·78
	·0589	·38	116	294·6	58	14·4	149	65·	1 0	1 3	·107	·271	Steady	3	200	3395	526	...	...
§ Round Rod.	·0589	·38	116	294·6	52	11·1	145	62·7	9 7	9 37	·109	·276	Alternating	30	200	3395	526	380	76·
	·0589	·38	116	294·6	52	11·1	145	62·7	9 37	9 40	·109	·276	Steady	3	200	3395	526	...	...
‖ Round Rod.	·0589	·38	116	294·6	52	11·1	145	62·7	11 57	12 26	·109	·276	Alternating	29	200	3395	526	305	61·
	·0589	·38	116	294·6	52	11·1	145	62·7	12 29	12 32	·109	·276	Steady	3	200	3395	526	...	...

* In this case the direct current was tried first, and when deflection ceased it was cut off and deflection allowed to fall to ·100; then the alternating was put on, when it rose to ·103 *only*. † 7 No. 14. ‡ Diagram No. 2. § Diagram No. 1. ‖ Diagram No. 3.

* Paper read before the British Association, in Section A, at Newcastle-on-Tyne, September, 1889.

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The connections for the transmission of currents are shown by Fig. 2. A was an ammeter—one of Sir William Thomson's recent Hecto-ampere Balances—and B a voltmeter, reading to a hundredth of a volt, specially constructed by Messrs. Ayrton and Perry on their latest hot-wire method.

C were 15 secondary cells for the production of steady currents, and D was a Lowrie-Hall converter to transform the high-tension currents (2,000 volts) of the electric light station to the low-tension currents (4 volts) required for measurement. The range of variation of frequency was not very great, nor so great as I should have wished. It would have required other converters to have extended the range, for with the converter having the ratio 2,000/4 any reduction in frequency lowered the E.M.F. at the two ends of the conductors, and it was impossible to get the requisite current through the conductors. E was the alternate-current switch, and F that for continuous currents. L was a resistance of platinoid used to equalise the E.M.F. of the accumulators and converter. M was a variable resistance used to adjust the current. The current density was in excess of that adopted in practice, and the currents were so adjusted that they gave a convenient reading on the scale, and they were kept constant during each experiment. All the connections were made of very massive copper.

5. In the preliminary experiments that were made to determine the mode of procedure and the final form of the apparatus, conductors of copper, iron, lead, and platinoid were used, but in the final experiments only iron and copper were employed. Each metal was taken of the same length and of the following forms:—round rod, flat rod, tube, and stranded cable.

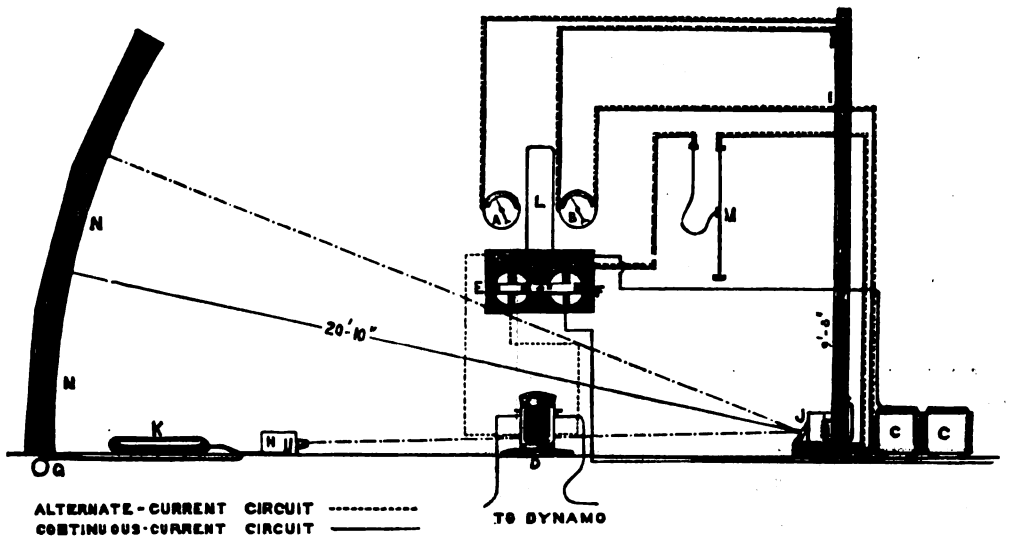

FIG. 2.

B.—IRON.

Description.	Section. sq. in.	Section. sq. cm.	Length. in.	Length. cm.	Temperature. Air. F°.	Air. C°.	Metal. F°.	Metal. C°.	Elongation. Time. Started.	Time. Stopped.	Extreme Elongation. in.	Extreme Elongation. cm.	Current.	Time on.	Amp.	Density. sq. in.	Density. sq. cm.	Dynamo. Speed.	Dynamo. Frequency.
									h. m.	h. m.				min					
Small Round Rod.	·0706	·45	116	294·6	48	8·8	182	83·3	8 53	9 20	·104	·264	Steady	27	98·9	1400	219	...	..
	·0706	·45	116	294·6	48	8·8	207	97·2	9 20	9 25	·124	·315	Alternating	5	67·8	960	150	404	107·73
Flat Rod	·066	·361	116	294·6	49	9·4	197	91·6	9 45	10 20	·115	·292	Alternating	35	67·8	1210	187	404	107·73
	·056	·361	116	294·6	50	10·	108	42·2	10 20	10 29	·045	·114	Steady	9	67·8	1210	187	...	...
Stranded Cable.	·178	1·148	116	294·6	54 to 56	12·2 to 13·3	139	59·4	7 35	8 17	·065	·165	Steady	42	177·9	1000	155	...	...
	·178	1·148	116	294·6	56	13·3	230	110·	8 17	8 32	·1358	·343	Alternating	15	177·9	1000	155	400	80·
Large Round Rod.	·196	1·266	116	294·6	56	13·3	230	110·	8 45	9 4	·1358	·343	Alternating	19	141·9	724	112	400	80·
	·196	1·266	116	294·6	56	13·3	125	51·6	9 4	9 40	·054	·137	Steady	36	141·9	724	112	...	...
Small Round Rod.	·0706*	·45	116	294·6	56 to 58	13·3 to 14·4	232	111·1	11 53	12 12	·1358	·343	Alternating	19	67·8	960	150	577	105·78
	·0706	·45	116	294·6	58	14·4	138	59·	12 15	12 28	·062	·157	Steady	13	67·8	960	150	...	...
Small Round Rod.	·0706†	·45	116	294·6	52	11·1	196	91·1	8 3	8 32	·109	·276	Alternating	29	67·8	960	150	380	76·
	·0706	·45	116	294·6	52	11·1	116	46·6	8 32	8 54	·05	·127	Steady	22	67·8	960	150	...	...
Small Round Rod.‡	·0706	·45	116	294·6	56 to 58	13·3 to 14·4	194	90·	3 26	3 47	·106	·269	Alternating	21	79·5	1126	176	305	61·
	·0706	·45	116	294·6	58	14·4	144	62·2	3 47	4 1	·067	·170	Steady	14	79·5	1126	176	...	...

* Diagram No. 1. † Diagram No. 2. ‡ The current being higher in this experiment is accounted for as follows: In the other experiments the greater number of alternations produced much greater back E.M.F., which kept the current down. In this experiment, the number of alternations being very low, the effect of self-induction was also low, and the varying resistance used to regulate the current was insufficient, consequently the current given was the lowest obtained. In the direct-current circuit there was a constant resistance besides the varying one, and it was therefore possible to keep that down in the other experiments, but of course in this experiment the steady current was made the same as the alternating.
§ Off scale.

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The various dimensions are given in the tables. The temperature was in all cases determined from the elongation of the conductor.

6. The observations were taken sometimes with steady currents and sometimes with alternating currents first. Each kind of current, after being switched on, was kept constant until all expansion ceased, after which the current was instantly changed to the reverse kind, and any change of elongation observed. Each experiment lasted from twenty minutes to half-an-hour. The results are tabulated on the Tables A and B, and some of the experiments plotted as curves on the diagram (Fig. 3). For this latter purpose observations were taken and recorded at every minute. The abscissa is *time* in minutes, and the ordinates elongation in thousandths of an inch.

7. As regards copper, it is very clear that, whether the current were steady or alternating, the effect of heat generated in the conductors was virtually the same; but of the different forms the tube gave the best results, owing, doubtless, to the increased radiating surface.

8. The performance of the iron conductor is very decided. Here we have a large increment of heat, due clearly to reversals of circular magnetisation. Hysteresis evidently plays a most important function, and the conductor in consequence becomes a source of heat, which varies in intensity, not only with the strength of the current, but also with the frequency of the alternations.

9. The difference of behaviour between iron and copper is very marked in the sounds they emit when transmitting alternate currents. Iron vibrates mechanically, and emits loud, powerful sounds, filling the room with a roar, and increasing in intensity with the frequency. The sound of copper is very slight, and only perceptible when the ear is close to the conductor, even with the maximum current. It is only what one would expect from rapid variations in emissivity under such alternations.

This vibration, so marked in iron, has a very important bearing on the durability of the insulating material; for it is difficult to conceive any material that could stand such molecular disturbances without injury for any length of time.

10. This generation of heat in iron conductors leads to the conclusion that the fusing current for small wires would differ considerably between steady and alternate currents. All tables are made on the basis of steady currents. No. 11 iron wire, 116 "mils" (·295 centimetre) in diameter was taken.

Calculating fusing current	.....	122 amperes.
Steady ,,	.....	120 ,,
Alternating ,,	.....	92 ,,

No difference was observed with copper.

11. The general conclusion to be drawn from these experiments is that practically no serious error has been made in the form of conductors so much used for alternating-current systems, and that nothing cheaper or better has been devised than a simple stranded conductor, coated with a suitable insulating coating, and protected outside with lead, or some impervious and strong material.

They do not solve the question of the distribution of current density through the section of the conductor, but they do show that within the range of practice the total flow of energy is the same in copper conductors, whether it be urged by alternate or by steady currents.

ELECTRIC LAUNCHES ON THE THAMES.*

BY PROF. G. FORBES.

This Paper on Electric Launches on the Thames has arisen out of the fact that during the past summer, while I was living down the river at Bray, I was enabled to have the opportunity of keeping one of those electric launches, which have been built by Messrs. Tagg lately, and electrically equipped by Messrs. Immisch. I thought it would be interesting to draw attention to one's experiences in this connection. I speak not only from my own observations, but from those of everyone who has used them on the river, and also the views of a very large number of those who have seen the performances of these boats and watched them, and who are habituated to the river, when I say that there is hardly the slightest doubt that in the course of a very few years the steam launch as a pleasure boat on the River Thames will be entirely abolished.

On the river Thames there are some special peculiarities which make the electric launch peculiarly suitable, and it by

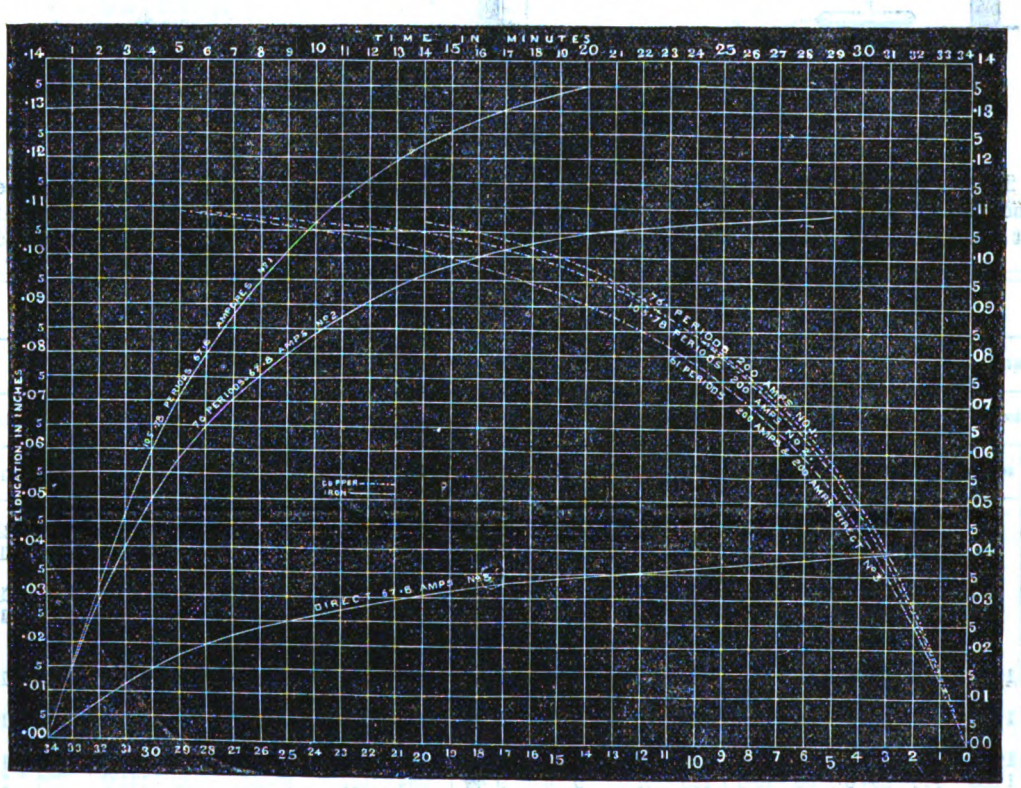

FIG. 3.

* Paper read before the British Association in Section G, Newcastle-on-Tyne, September, 1889.

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no means follows from what I have said that in other cases the electric launch will be as speedily and universally adopted. Among the points worthy of notice are—in the first place, that launches on the river are required chiefly in summer, when the heat, smoke, smell, oil and dirt of a steam launch are objectionable; and also that, owing to the larger traffic, and to prevent injury to banks and boats which are tied to the banks on the river, it is impossible on the Thames to allow high speeds in launches. Hence a comparatively small supply of storage batteries or accumulators is required for driving the electric launches at the very moderate speeds which are permissible on the river Thames.

It may be also added that on the Thames it is easy to secure a sufficient number of charging stations. At present there are four or five at easy distances apart. Eventually there can be little doubt that the hotels on the river will find it financially a good plan to be lighted electrically, and then this power which they have on the premises can be used during the night for charging the storage batteries of launches.

The house which I occupied was at Bray, just below Maidenhead, and each night I took the launch by myself, towing a boat behind, up to the charging station (which was not a mile away). I left it there to be charged during the night, and by breakfast time the launch was outside ready charged, with a sufficient supply to last me the whole day. I may mention that I never exhausted the complete charge of the batteries in my launch during the whole time. I generally went out shortly after breakfast, spent the whole day on the river, very often coming home at eight o'clock, and afterwards taking it up to the charging station in the evening; and certainly forty miles was not by any means enough to exhaust the supply of electricity on the launch.

The management of the boat is extremely easy, the steering gear and everything about it being perfectly handy. There was no difficulty in crowded locks—going in and bringing up alongside of a lock with the greatest ease.

This launch, which was called the "Delta," is 33ft. in length, has a beam of 6ft., the draught is 15in. forward and 18in. at the stern. She is fitted with 44 cells, weighing in all 2,520lb. She is steered by a wheel in front within reach of the three handles which are required for working her. The first of these handles is used for putting the current on or off, the second one for putting it to half-speed or full-speed, and the third for going ahead or astern. The first one is mechanically moved with the others, so that they cannot be moved without first cutting off the current. Fusible cut-outs are inserted in the circuit, so that if the propeller becomes jammed by weeds or by going aground the motor will not burn up. The speed of revolution of the motor, which is coupled direct to the propeller, is 720 revolutions per minute for full-speed, and 510 revolutions for half-speed. The speed is only between five and six miles an hour for full-speed. This is perhaps the weak point of this launch. I must say there are times when you are going against a strong current in some parts of the stream where a greater speed would be desirable, and it becomes a little tedious creeping up. It is only in a strong stream that one really finds it a little too slow, and for all ordinary purposes it is quite enough. However, the speed might be very advisedly increased a little, I think, by putting in more accumulators, which the launch could easily carry under the floor without overloading. At present the batteries are all under the seats on each side of the boat, and thus the whole of the space in the boat is clear for passengers. My launch could easily have carried twenty with perfect comfort. It is here that the electric launch has a very great advantage over the steam launch; if we consider the size of the launch, and the number of passengers it will hold, the electric launch is really the cheaper of the two.

I spent a day in making tests of the performance of the launch, which may be of a little interest, though they do not go very far. I started from my house one morning at 11:45. I made allowance as I went through the locks for the time that was taken in going through locks and so on, and for other stoppages, and timed everything during the whole way. At one minute past four I was near Hambleton Lock, and began the return journey. Stopping an hour at Medmenham Abbey, I reached Bray again at 7:48 p.m. During all this time the exact measurements of the time were taken, and the result was that in the outward journey up stream the average speed was one mile in 11·3 minutes, and on coming down stream the average speed was one mile in 10·2 minutes. The average of these two is 790ft. per minute. On arrival at home the stern was attached to a spring balance connected by a rod with the shore. The pull at full speed was then measured, and found to be 97lb., which, although it does not accurately represent the pull when the launch is in movement, still it does so with considerably close approximation. This gives us 1·44 horse-power, or 1,074 watts, including electrical losses, slip, and all friction. The pressure of 97lb., over 790ft. per minute, gives that result. The average pressure at the motor terminals during the run was 78 volts, and the average current was 23 amperes, which gives 1,794 watts expenditure. This gives a total efficiency, including all these losses of slip, friction, the end thrust of the propeller, and the electrical losses in the motor, at 60 per cent., which seems to me an extremely fair performance in one of the first types of electric launches which have been constructed by these makers.

I would suggest that there is a very large field open in future—if somebody could be got to organise it, for the delight of those who wish to use these extremely convenient launches on the river—namely, that, in order to supply the enormous demand which will certainly exist after a few years for charging stations, negotiations should be opened by somebody who has the energy to do so with the Thames Conservancy and also with the mill owners—which exist at nearly all the weirs—so as to establish charging stations with water-power at nearly every one of the weirs on the part which launches frequent, and thus to establish what would undoubtedly be a most perfect method of launching in any part of the world.

After a few remarks from Lord Russell, the President (Mr. William Anderson), in proposing a vote of thanks to Prof. Forbes, said there was no doubt a great future for electric launches. One of the Ordnance factories, Waltham Abbey, was under his command, and an electric launch was used there for going about among the network of canals which intersects that factory, in which dangerous operations are carried on, and where it is not desirable to have anything in the shape of fire. The launch answered its purpose perfectly; and it answered in another way incidentally—that is to say, at night, when it is not wanted for cruising about the canals, it is brought alongside an office, and the wires are carried into the office, and the charge in the batteries is used for the electric light during the hour or two that it is required.

TELEPHONE COMMUNICATION BETWEEN LONDON AND PARIS.*

BY W. H. PREECE, F.R.S.

The practicability of speaking by telephone between London and Paris has recently been carefully examined both by the French and the English electricians. The distance between the two places is 275 miles, viz., 74 miles between London and Dover, 21 miles from Dover to Calais, and 180 miles from Calais to Paris. It is very easy to speak over such a distance, if the wires be aerial and of thick copper, but the insertion of underground wires at each end, and of a cable in the middle, place difficulties in the way that have to be surmounted. It is not a question of apparatus—it is solely the distribution of the electrical resistance and capacity of the different portions of the line, and the arrangement and material of the wires.

Speech is already commercially maintained between Paris and Brussels (190 miles), Paris and Lille (158 miles), Paris and Rouen (80 miles), Paris and Havre (135 miles), Paris, Lyons and Marseilles, the latter being a distance of nearly 600 miles; but in all cases they are aerial wires, excepting for a short length (about two miles) of underground work in Paris.

The author has experimented on the cables between Dover and Calais, between Holyhead and Dublin, and between South Wales and Wexford. The conditions to be fulfilled are very

*Paper read before the British Association in Section G, Newcastle-on-Tyne, September, 1889.

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simple. The circuit must be metallic, the material must be copper, and the product of the resistance of the line, R, and its capacity, K, must not exceed a certain figure. It has been determined roughly by experiment that when

K R =	15,000	speech becomes	impossible.
=	12,500	,, ,,	possible.
=	10,000	,, ,,	good.
=	7,500	,, ,,	very good.
=	5,000	,, ,,	excellent.
=	2,500	or under, speech becomes	perfect.

We have thus a species of Beaufoy's scale applied to telephonic communication.

A circuit approaching as nearly as possible one between London—Paris was made on an artificial cable and it was found to comply with the requirements.

An actual circuit was then made from Worcester, through twenty-seven miles of the London underground system, to Baldock, on the Great Northern Railway, giving similar electrical conditions and with the same result.

It may be considered as absolutely settled that speech is possible between London and Paris.

In the United States speech is maintained between New York and Boston (350 miles), and in many instances to distances exceeding that between London and Paris, but they have not to surmount the difficulties of underground wires at each end, and of a cable in the middle.

The PRESIDENT (Mr. William Anderson) asked why the experiment was not tried direct between London and Paris?

Mr. PREECE said the reason was that all the wires between London and the coast and between Calais and Paris were iron wires, and it was quite impossible to speak over an iron wire to a greater distance than 100 miles. It was only possible to speak at long distances by the aid of copper wire.

Mr. BIGGS asked Mr. Preece whether the highest figure he had given was the absolute limit to which the telephone was possible, or whether, with an alteration of the transmitter and the receiver, it would be possible to have telephony with a higher product than 15,000.

Mr. PREECE replied that 15,000 was the limit now with the present apparatus and with the present means. He did not anticipate any advance in the apparatus; the apparatus itself was nearly as perfect as one could hope it to be, but he did anticipate very great advances in the means of carrying the currents in the form of conductors and in the form of the circuit. They were now quite on the threshold of the subject. The introduction of the telephone and the introduction of alternate-current working in electric lighting were quite opening people's minds to a new field in electricity, and they did not know where they would go to. All that was known was that at the present moment they were on the shore of some unlimited sea, and what might open in the next ten years they could not tell.

SERIES ELECTRICAL TRACTION.*

BY EDWARD MANVILLE, M.I.E.E.

The expenses of horsing a tramway form such a serious proportion of the total working expense that any cheaper effective method of propulsion will naturally be gladly received by the various companies.

Steam and compressed air have been extensively tried, and although in some cases their expense has compared favourably with horsing, the machinery used is so cumbersome, and the nuisance so great, that even companies who have incurred the expense of abandoning horses in favour of steam are seriously meditating the adoption of electricity.

The cable systems have met with considerable success in the United States, and have achieved some measure of success in the United Kingdom; but the conditions under which a cable line can be operated economically are tremendously heavy traffics, such as do not exist in the United Kingdom, but do in the United States, where, as is well known, tram cars are practically the only available street conveyances.

Many leading authorities in tramway administration, who have tested and considered the various methods of tram car propulsion, have of late publicly expressed their confidence in the great suitability and economy of electricity for the purpose.

* Abstract of a Paper read before the British Association at Newcastle-on-Tyne, in Section G, September, 1889.

To distribute electrical power economically from one generating station over distances such as are covered by tramway systems of any extent, it is essential that high-tension currents should be employed, so as to minimise the loss of power in the conductors. Now, if the full tension of such currents were applied to the driving motor on each car, grave difficulties would present themselves in manipulation and in preserving the motor from injury. By the series system, however, it is possible by running the motors in series—as the name indicates—to attain the maximum ease of manipulation together with perfect safety to the motor. This was recognised at an early stage by the late Prof. Fleeming Jenkin and Profs. Ayrton and Perry, and the first electric locomotives ever run in series were used by them in connection with telpherage.

The subject of electrical traction reached such a degree of prominence in this country that early last year steps were taken to demonstrate the practicability of running electric motors for tramcars in series with each other, and an electrical tramway on the series system was equipped and put into operation at Northfleet.

The essential parts of an electrical tramway line in which the motors are run in series are:—An electric generator, producing a current of constant quantity and an electrical pressure varying continually according to the total work being done by the whole of the motors together; the conductor taking the current from the generator to the motors provided with automatic switches of such a character as to enable the continuity of the conductor to be broken as long as the motor is in electrical contact with the open ends of the conductor, and to be closed as soon as the motor, in passing away, ceases to be in contact with the ends of the conductor.

This operation must be performed without disturbing the metallic continuity of the circuit, and without short-circuiting the motor.

The generator used at Northfleet is one of Statter's patent constant-current dynamos, in which type of machine the E.M.F. is varied by the alteration of the position of the brushes on the commutator effected by an electrical regulator. The current, after passing through the regulator, goes to a highly-insulated cable, reaching the whole length of the line. The cable is cut at distances of 21ft. along the line, and the ends of it are led into terminals connected with the opposite faces of a "spring-jack," which is at the same time the automatic switch and contact point from which the current is collected. From the last "spring-jack" at the end of the line, a return cable, with its insulation unbroken, is brought back to the other terminals of the generator, owing to the line at Northfleet being a single track.

The "spring-jack" just referred to consists of a pair of glazed earthenware blocks, 14in. by 3in. by 4in. To each block is attached, by means of a double spiral ring, a gun-metal casting, curved at the ends, but flat in the centre. The springs are of sufficient strength to press the two castings together with a force of 6lbs. Under the car, and for its entire length, is the collector, or "arrow," which consists of two thicknesses of india-rubber belting, each having a broad brass strip rivetted to it for nearly its entire length. The nose of the "arrow" at each end is shod with wrought iron, brought to a knife-edge, so as to easily force its way between the two faces of the "spring-jack," which automatically close after its passage. The conductor on each side of the "arrow" is lapped round one end, and an insulated space is left, slightly greater than the surface of contact of the "spring-jack," near the extreme ends on opposite sides. By these gaps, the passage of the collector, from one "spring-jack" to another, is effected without short-circuiting the motor.

The conductor on each side of the arrow is connected by an insulated cable with the motor carried on the car. On each platform of the car are two strong switches. One of these serves to reverse the direction of the rotation of the armature by altering the connections between the field magnets and the armature, the other regulating the power of the motor by shunting more or less current for the field magnets. Three speeds are provided for, and the stopping of the car is brought about by completely short-circuiting the field magnet, still allowing the current to pass through the armature.

The motors are run at 400 revolutions per minute, delivering at this speed, when the field magnets are fully excited, 15 horse-power on the brake. This slow speed was adopted to do away with intermediate gearing between the motor shaft and the car shaft, which has up to this time been the usual practice.

At Northfleet the motor pinion gears direct with a spur wheel on the car shaft in the ratio of 1—4½. The gearing is double helical, with a view to noisless running, and the practical working of this gear is most satisfactory.

The motors are mounted in a way now generally adopted in the United States, one end being supported by two half bearings on the driving shaft of the car, the other end being suspended by a spiral spring from a stout beam across the car body.

The motors are of the Elwell-Parker type, and the field magnets are connected in series to the armature. The generator is driven by a Robey compound under-type engine of 10 horse-power (nominal), with a locomotive boiler over it.

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The appearance of the tramway on the road surface is in all respects similar to that of an ordinary tramway, the conduit through which the "arrow" travels, and in which the "spring-jacks" or contact points are situated, being formed beneath one of the running rails. This running rail differs from the ordinary tramway rail, inasmuch as the tread and guard portions consist of two separate and independent rails, having a narrow slot $\frac{7}{8}$in. in width between them, through which the mechanical connections between the "arrow" travelling in the slot and the car body are situated. The rails are supported by means of cast-iron chairs or yokes, to which they are securely bolted. These yokes are placed at intervals of about 4ft., excepting at the rail-joints, where they are closer together, the sides and bottom of the tube between these yokes being formed of Portland cement concrete. The rails are made in 21ft. lengths, corresponding with the distance apart of the "spring-jacks," and at each rail-joint a special chamber is formed, having a convenient removable lid, by means of which access is obtained to the "spring-jacks." The centre of the tube is placed somewhat inside the track, in order that the "arrow," when travelling, shall not be directly underneath the slot, so as to avoid the danger of water from the road surface in wet weather falling directly on the "arrow," and also with a view to protecting the "spring-jack" cheeks themselves in a similar manner. The cable joining the "spring-jacks" is led to an independent 3in. earthenware pipe, running from chamber to chamber, and in this tube also is laid the return cable. Some special construction of points and crossings is necessitated, owing to the junction or crossing of the two tubes underneath the track, which involves a considerable projection of unsupported tongue. The mechanical details of the system were designed by Mr. Joseph Kincaid, and carried out for him under the supervision of Mr. J. S. Waller.

It may be well to point out, in series running, that, owing to the employment of a current of constant value, it is impossible for the most inexperienced car driver to damage his motor by either too rapid starting or by reversing whilst running; indeed, it is a positive advantage when descending a hill to check the speed of the car by altering the field connections so that the armature tends to revolve in the opposite direction to that in which the car is travelling, as the power that would otherwise be lost in braking the car is actually added to that produced by the generator, and thus large systems, with many cars and varying gradients, would appreciably reduce the total power required to be generated and the consequent consumption of coal.

These advantages, combined with the efficiency of distribution as regards the percentage of power lost in the conductors, with, at the same time, but a low difference of potential at the terminals of each individual motor, may be regarded as the main advantages of series running.

There was no discussion, but in reply to the Chairman and Mr. Preece, Mr. MANVILLE said the points occurred on the level of the shank, they would be about on the rail-level. Everything was quite clear down below; there were simply two tubes for the arrow to travel in, and the shank was guided by the point on the rail-level so as to bring the arrow in a proper direction—the same direction as the car was travelling in. The points worked quite automatically, and they were pressed over by a spring in one direction. The maximum gradient was 1 in 32, and it was nearly a quarter of a mile long. They had had no trouble in running up the gradient. The cars carried 26 passengers inside. At Northfleet with two cars the pressure might rise to 500 volts; the average would be from 300 to 350 volts. The effect of reversing the motor in checking the speed of the car going down hill is a very important point. It is not seen perhaps at first sight that in running in parallel it is practically impossible to utilise the brake-power of a car in going down hill. The advantage was only got from it at the few moments when the motor is running at a higher electromotive force than the generator. In series running, where each motor forms an integral part of the circuit, reversing the direction and the rotation of the armature of the motor adds volts to the system which are taken by the generator, and therefore by the steam engine, until the very moment at which the car is stopping. At Northfleet they could actually turn the engine back against the steam when they were going down hill, that is to say, the power developed by the car going down hill passing through the circuit is more than that at the engine at the moment.

BOOKS, &c., RECEIVED.

"Abstracts of Papers in Foreign Transactions and Periodicals." (The Institution of Civil Engineers.)

Syllabus of Lectures: City of London College.

"Die Telegraphentechnik." By C. Gramiekel and Dr. K. Strecker. (Berlin: Julius Springer.)

The *Journal* of the Iron and Steel Institute, No. 1, 1889. (London: E. and F. N. Spon.)

The Glasgow and West of Scotland Technical College. Syllabus of Day and Evening Classes for the Session 1880-90.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September* 7, 1889.

It would appear that negotiations have recently been entered into between the Postmaster-General, Mr. Wanamaker, and the Western Union Telegraph Company, looking to the establishment of a somewhat novel scheme of postal telegraphs. According to the reports that are now current upon the subject, the Western Union Company will reduce the rates for all short-distance messages, provided that the free delivery system of the Post-office could be used to deliver messages. The cost of delivering messages is one of the heaviest expenses that a telegraph company has to bear, and if economy could be effected in this quarter there could be a reduction in telegraph rates. The idea is that while the Western Union and other telegraph companies should handle the messages as heretofore in the operating rooms at both ends of the line, the Post-office would receive and deliver the messages by means of its present postal force. A further idea is that the department should sell telegraph stamps, thus practically constituting every post-office a telegraph office. This method of co-operation answers in many respects to the system by which the Government now carries on its regular Post-office work. It collects the letters at each end, but it does not own the railroads that transport the mail bags, nor, as a general thing, does it operate on its own account the mail waggons which carry the bags from the post offices to the railway depôts. The idea as proposed seems to have met with not a little favour, and it makes friends on both sides, not only among those who are opposed to Government telegraphs, but those who wish to see the Government giving the people the benefits of cheap telegraphy. There can be no doubt that should such a scheme be adopted, and the contract be entered into with the Western Union Company and the Postal Telegraph Company, in which Mr. Mackay is understood to be interested, it would certainly do much to strengthen the position of those companies against all new comers, and practically give them the monopoly in telegraph business, even if they did not already possess it. So long as the new competitor could come into the field and pick up any business that offered, it would have a fighting chance, but if the business were largely handled through the Post office under contract, and if a new company, in order to bid, had to make enormous preparations for a plant, which failure to obtain the contract would throw on its hands, it is not very likely that capital would be willing to make the effort. In the meantime, while the public is pondering on this new idea, the dispute between the parties as to what will be the rate for strictly Government business remains unsettled, although Dr. Norvin Green has had decidedly the best of it. It is said that the terms on which the Government messages are to be sent in future will not be one mill per word, but two-fifths of a cent per word for night messages and half a cent for day messages.

The fact that the Government of the country has never been sufficiently appreciative of the importance of the telegraph has been very forcibly brought out in the article contributed to the *Century* this month by Dr. J. Emmet O'Brien on "Telegraphing in Battle." Dr. O'Brien was himself one of the members of the United States Military Telegraph Corps, whose good work during the civil war led to the organisation of a large and efficient telegraph force in connection with all the armies of Enrope. Dr. O'Brien's article, which is full of interesting incidents and anecdotes, goes to show that while hundreds and hundreds of operators gave their services to the country and were wounded, imprisoned and killed, not the slightest substantial recognition has ever been taken of their services. The operators who did such a good work and survived have never been awarded pensions or any sort of official rank, nor has any recompense whatever been made to the families of those who gave their lives. Efforts have been made from time to time by certain of them to secure that which is undoubtedly their due, and they have received the warmest support from such men as Grant, Sherman, Sheridan, and McClellan, who well know the value of the telegraph and of the services so unstintingly given, but up to the present time nothing practical has come of the agitation.

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In publishing the portrait and biographical sketch, this week, of Mr. J. Frank Sprague, who was at one time a lieutenant in the United States Navy, the *Electrical World* takes occasion to point out the intimacy that has sprung up between the Navy Department and the growing electrical industries of the country. It would seem that owing to the smallness of the American navy since the close of the civil war, and down to a very recent date, the sea has not offered many attractions to the well-trained young graduates from Annapolis, and the consequence is that many of them, availing themselves of the instruction given in electricity, have turned their thoughts and energies to electricity, and, as in the case of Mr. Sprague, have succeeded in making their mark there. Among such men may be also mentioned Dr. Louis Duncan, of Johns Hopkins University, and Mr. Shallenberger, of the Westinghouse Company. In Mr. Sprague's case the rapidity of rise in the profession has been phenomenal, and that gentleman deserves no small amount of credit for the ability and enthusiasm with which he has thrown himself into the work of developing the applications of electrical power. Mr. Sprague was fortunate in receiving the support of the Edison interests, and in enjoying the backing of such a determined and thoroughbred pioneer as Mr. E. H. Johnson, of the Edison Company, and the result has been that Sprague stationary motors are doing their work in enormous numbers everywhere, while Sprague electric railways are to be found in all the progressive States of the Union.

In addition to affecting horses, the electric railway must also, it would seem, have some effect in due time on the shorter of the steam railways. Thus, for example, in conection with the Thomson-Houston road recently put in at Rochester, New York, and running from that city to the summer resort of Ontario Beach, it is stated that the electric railroad has already reduced by one half the patronage of the steam road that it parallels. It can be readily understood that in the summer months, when open cars are used, the electric locomotive must be decidedly preferable to the steam locomotive. It emits neither smoke nor steam, it makes little dust, and throws off no disagreeable soot or small debris of coal, and its motion is remarkably smooth.

We are by no means as far along as you are in the matter of electric launch construction, although, perhaps, we even up when it comes to building "Puritans." The launch "Electron," which has recently made its appearance on the Hudson River, deserves passing mention, however, from the fact that it has made a run of 70 miles, and that it is, so far as can be ascertained, the largest craft of its kind ever built and put into commission. The "Electron" has a hull 36ft. long over all, built of sheet-iron plates. She is decked fore and aft, and has a nice roomy cabin, with a cupola on top at the forward end of the cabin for the pilot house. She is fitted up with a motor from the Electro-Dynamic Company of Philadelphia, which delivers from 15 to 20 horse-power, and which acts directly with a screw, making about a thousand revolutions a minute at maximum speed. The current is furnished by 200 cells of the new motor battery, made by the Electrical Accumulator Company, and known as the 23M type. Each of these accumulators is contained in a vulcanite cell, and consists of 23 plates, which are held apart by thin vulcanite forks. The 200 cells complete weigh four tons. They are arranged about the boat, some in the bottom of the keel, others in the forward deck, and the rest under the seats and along the sides of the cabin. The boat is well trimmed, and the batteries are so disposed as not to infringe in any way upon the space available for passengers. This boat not only made the run down the Hudson River from Newburgh to Newark, but has also gone out through the Narrows to sea as far down the coast as Rockaway Beach.

The American Association for the Advancement of Science has just been holding its meeting at Toronto, under the presidency of Prof. Mendenhall, and a great many Americans have availed themselves of the opportunity to take a trip to Canada, just as they did when the British Association held its memorable meeting in 1884 at Montreal. The meeting is still in session, but will end this week. A few electrical Papers have been presented, among them being one by Prof. H. S. Carhart, of Ann Arbour University, Michigan, on an "Improved Standard Clark Cell, with Low Temperature Coefficient." Prof. Carhart pointed out in his Paper that there were three objections to the Rayleigh form of Clark cell, described by Lord Rayleigh in 1885. One of these was the high and variable temperature coefficient. The second was that it was not constructed in such a way as to keep the mercury apart from the zinc when shaken in transportation. The third defect was the local action taking place by which zinc replaced mercury in the mercury salt, and the zinc became amalgamated, the amalgam even creeping up so as to reach the solder at the copper wire. Prof. Carhart brings forward an interesting form of cell, in which he says that these difficulties are perfectly overcome, while in addition to the low temperature coefficient, great safety in transportation is secured. The coefficient he has obtained is only 0·038 per cent. per degree centigrade, which is somewhat less than one half the coefficient of the Rayleigh form. Almost absolute safety in transportation is also secured by confining the mercury to the bottom of the cell, thus precluding the possibility of its reaching the zinc and short-circuiting the cell, no matter how violently it may be shaken. There is also the advantage of increasing the E.M.F. about 0·35 per cent. above the old form, and there is greater uniformity and constancy. Prof. Carhart also presented a Paper on the "Maxwell Electro-Magnetic Theory of Light," and Prof. Gray brought to the attention of the Association the beautiful new instruments of Sir Wm. Thomson, which have recently been acquired for the Standardising Laboratory of the Ross Polytechnic Institute, at Terre Haute, Indiana.

CORRESPONDENCE.

THE DISTRIBUTION OF ENERGY BY MEANS OF ALTERNATING CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My friend M. Worth has informed me of the series of articles which you were good enough to publish in your journal on the subject of my alternate-current investigations. I was very glad to find that they had attracted your attention, and I thank you for having laid my work before your English readers.

We are, I think, in general agreement, and you rightly remarked that if I indicated solutions of the problem which were scarcely practical it was because I made a great point of proceeding, as far as possible, analytically and indicating all the solutions which naturally presented themselves. I have, however, to reply to two of your observations.

First. You say in your issue of August 9, p. 346:—"It is permissible to question whether, in the absence of direct experimental evidence with modern machines, this decision is as yet wholly justifiable." At the recent Congress of Electricians at Paris, Mr. Gisbert Kapp said that in the latest experiments of Mr. Mordey there was practically no fear of machines employed as motors getting out of synchronism, for in order to do so the work thrown on them must be treble the normal load. May we not invert this proposition and say, all risk of the machines getting out of synchronism is avoided by calling upon them to develop a motive effort equal to only one-third of which they could develop, all things being equal, with a suitable difference of phase. This completely justifies what I said.

On page 399 of your issue of August 23rd you designate as incorrect a proposition so simple that doubtless it is merely a case of misunderstanding. I said that the mean quantity of electricity put into motion *in the same direction* during a second, in a given circuit, by an E.M.F. *variable but always in the same direction*, was proportional to the mean value of the E.M.F. and independent of the coefficient of self-induction of the circuit *at the end of a time long in comparison with the period of the variations of this E.M.F.*

I will restate my proof:—

Let E = the variable E.M.F., always of the same sign.
R = the resistance of the circuit.
L = the coefficient of self-induction of the circuit.
I = the current.
T = the period of the variations of the E.M.F.
t = some length of time.

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We then have at every instant

$$E = R I + L \frac{d I}{d t},$$

whence

$$\int_0^t E d t = R \int_0^t I \, d t + \int_0^t L \, d I.$$

The quantity E being always of the same sign, the term $\int_0^t E \, d t$ increases indefinitely with the time. The term $\int_0^t L \, d I$ represents, with a constant, the value of the flux of force generated by the passage of a current of intensity I multiplied by the number of times it meets the circuit. Its value cannot increase indefinitely with the time. It is, therefore, a periodic function, of which the period will be evidently equal to the period T of the variations of the E.M.F. when a regular *régime* has had time to become established. Hence, if we are considering a time *t very long in comparison to the period* T, we can neglect the term $\int_0^t L \, d I$, and write,

$$\int_0^t E \, d t = R \int_0^t I \, d t,$$

whence

$$\frac{1}{t} \int_0^t I \, d t = \frac{1}{R t} \int_0^t E \, d t,$$

which demonstrates that what I enunciated is true without any restriction whatsoever.

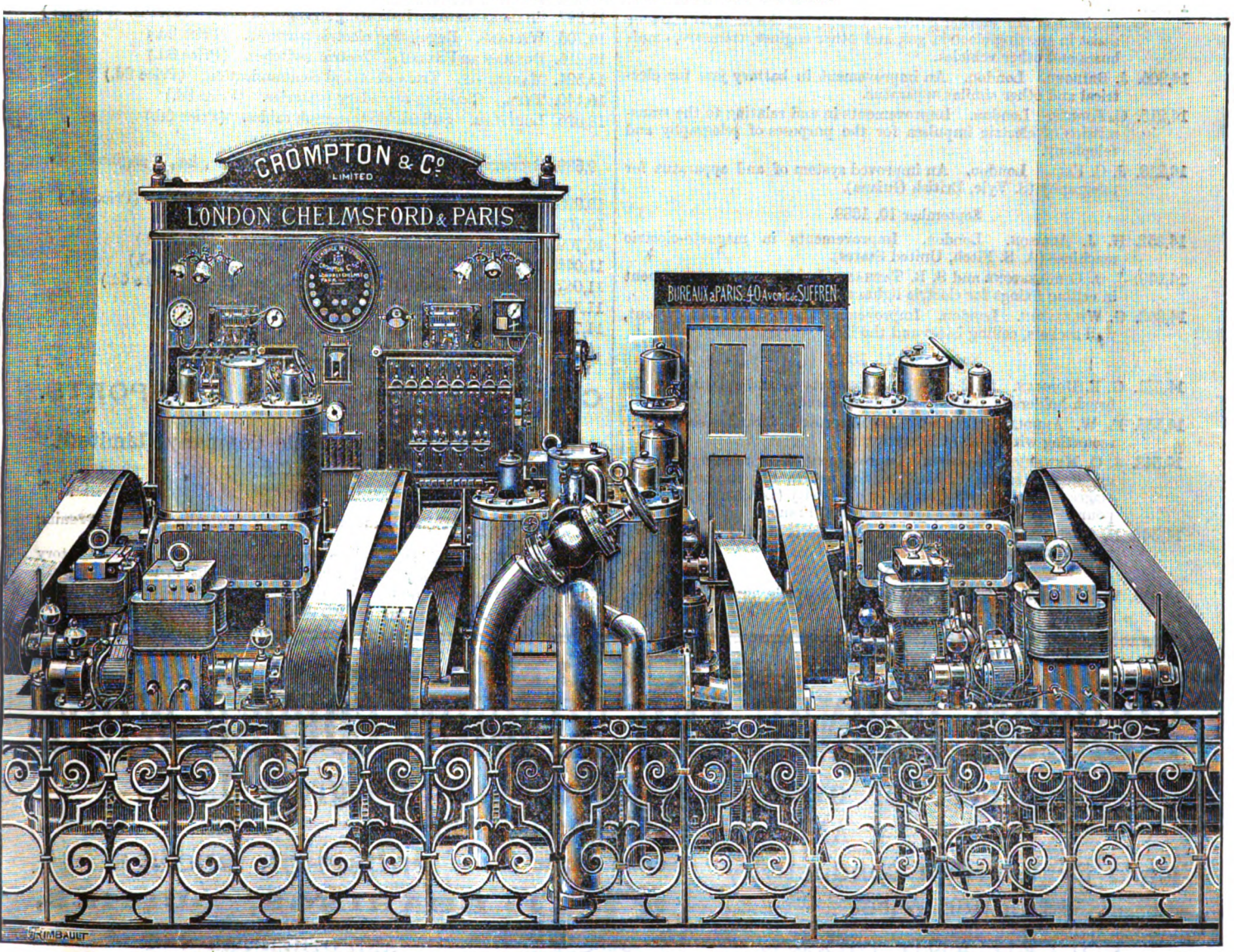
It must be noted, moreover, that there is no difficulty whatever in passing redressed currents round the field-magnets of very powerful dynamos. The self-induction has only the effect of damping the oscillations of the current. It is again a well-known fact that if any difficulty arises in charging accumulators with currents of this description, this difficulty can be overcome by introducing into the circuit a coil of low resistance and high self-induction. This is a fact that I have been able to verify for myself.

I should be greatly obliged if you would submit these few remarks to your readers, and thanking you in anticipation.—Yours, &c.,

M. LEBLANC.

Le Rainey, September 15, 1889.

MESSRS. CROMPTON'S EXHIBIT AT PARIS.



In our issue of June 21st we gave a description of the exhibit of Messrs. Crompton and Co. (Limited), of Chelmsford and London, at the Paris Exhibition. The illustration herewith shows that within the small space of 23ft. by 16ft. Messrs. Crompton have succeeded in placing engines, dynamos, and other machinery of 300 horse-power, sufficient to supply the lighting for the British, American, and portions of the French and Belgian Sections of the Exhibition. This *multum in parvo* will be appreciated by those who are acquainted with the many difficulties to be overcome in successfully disposing of so large a quantity of moving machinery in the comparatively small space at Messrs. Crompton's command. The illustration is from a photograph, and it may be mentioned that the rails in front are about 3ft. in height. On the occasion of a recent visit of President Carnot to the Exhibition, he warmly congratulated Messrs. Crompton on the good use they had made of the limited space allotted to them. The dynamos are of Messrs. Crompton's well-known type, full descriptions of which have appeared in *The Electrician*, and the engines are of the Westinghouse type supplied by Messrs. Alley and Maclellan. The belting was supplied by Messrs. Balderston and Co., of Glasgow.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

September 6, 1889.

14,086. W. C. JOHNSON and S. E. PHILLIPS. London. Improved means for effecting the insulation of electrical transformers, switches, switch-boards, fuses, commutators, and commutator brushes.

14,094. A. A. GOLDSTON. London. An automatic circuit-closing device for series circuits.

September 7, 1889.

14,113. M. IMMISCH. London. Improvements in switches for electrical propulsion purposes.

14,114. M. IMMISCH. London. Improved switch for electrical tramcars.

14,115. C. A. MCEVOY. London. Improvements in primary batteries.

14,116. C. BLANKE. Manchester. Disengaging apparatus actuated by electricity.

14,162. A. DE MERITENS. London. Improvements in treating and rectification or ageing alcohol or alcoholic liquors, or the like, by electricity.

September 9, 1889.

14,169. R. STEENBERG. Newcastle-on-Tyne. Improvements in or connected with telephones.

14,189. W. GIFFARD. Salford. Improvements in arrangements and mechanism for storing power and applying the same to start or assist in starting electric, gas, and other engines, tramcars, omnibuses and other vehicles.

14,206. J. BRIDGER. London. An improvement in battery jars for electrical and other similar apparatus.

14,215. G. FORBES. London. Improvements in and relating to the transmission of electric impulses for the purposes of telegraphy and telephony.

14,218. J. C. FELL. London. An improved system of and apparatus for telegraphy (S. Vyle, British Guiana).

September 10, 1889.

14,232. H. J. ALLISON. London. Improvements in magneto-electric machines (A. S. Fitch, United States).

14,249. J. O. GIRDLESTONE and S. B. TATHAM. London. An improvement in ceiling fixings for electric lights and switches.

14,262. G. WILKINSON. London. Improvements in switches and cut-out, wall sockets, ceiling bases and the like.

September 11, 1889.

14,321. G. E. DORMAN. Stafford. Improvements in and relating to the brush-holders of dynamo-electric machines.

14,333. F. W. ARNOLD. London. An improved incandescence lamp mounting with current interruptor.

14,342. J. C. MEWBURN. London. Improvements in or relating to accumulators or secondary batteries for use in lighting railway carriages and other conveyances by electricity (La Société Anonyme pour le Travail Électrique des Métaux, France).

14,345. R. G. GOATCHER. London. Improvements in the electro-pneumatic actions of organs.

September 12, 1889.

14,366. W. S. BOULT. Birkenhead. Improvements in or relating to arc lamps.

14,374. G. E. DORMAN. Stafford. Improvements in electric arc lamps.

14,377. J. M. BRADFORD. United States. Process of and apparatus for maintaining uniform current in electric lighting circuits.

14,380. G. ALLAN and J. W. BROWN. Liverpool. Improvements in telegraphy and in apparatus therefor.

14,390. G. E. DORMAN. Stafford. Improvements in apparatus for transmitting electric currents to and from the commutators of dynamo-electric machines.

September 13, 1889.

14,448. E. MOROSS. London. An electric chair for nervous and other diseases.

14,453. H. HARPER and R. P. WILSON. London. Improved means for regulating the working of dynamo-electric machines.

14,464. E. BATAULT. London. Improvements in electricity meters. [Date applied for under Patents Act, 1883, Sec. 103, February 15, 1889, being date of application in Switzerland.]

September 14, 1889.

14,485. A. GREENWOOD. Leeds. Improvements in magneto-electric bells or generators.

14,504. W. H. DOUGLAS and T. H. PARKER. Birmingham. An improved instrument for regulating electromotive force.

SPECIFICATIONS PUBLISHED.

1888.

11,897. SHALLENBERGER. Indicating strength of electric current. (Price 8d.)

14,703. WILLANS. Regulating electric currents. (Price 8d.)

15,216. DORMAN and SMITH. Electric switches. (Price 8d.)

15,324. MARGETSON. Train electrical communication. (Price 8d.)

16,140. TYER. Charging secondary batteries. (Price 8d.)

18,526. LOEFFLER. Submarine telegraph cables. (Price 6d.)

1889.

9,589. RICKETSON. Electrically indicating direction, &c., of engine shafts. (Price 8d.)

10,295. THOMPSON (Burke). Electric telegraphic apparatus. (Price 8d.)

10,708. CURRIE. Automatic electric cut-out. (Price 8d.)

10,709. CURRIE. Insulators for electric batteries. (Price 6d.)

11,044. THOMPSON (Alexander). Storage batteries. (Price 6d.)

11,067. SNEDEKOR. Insulation for electric conductors. (Price 4d.)

11,328. CORRENS. Electric accumulators. (Price 6d.)

11,732. ANDERSON. Electric telegraphs. (Price 1s. 1d.)

COMPANIES' MEETINGS & REPORTS.

Halifax and Bermudas Cable Company (Limited).

The statutory general meeting of this Company was held on Thursday, at Winchester House, Old Broad-street, under the presidency of Sir Alexander Armstrong.

The SECRETARY (Mr. James Hay) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, you are aware that this is the statutory meeting of the Company called within four months in accordance with the Act of Parliament as affecting the Companies' Acts. I do not know that I have very much to say to you, only that you will be interested to

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know the progress of business since the incorporation of the Company. We have concluded, as you may be aware, all our arrangements with the Government in a very satisfactory manner, and in our various negotiations with them we have received very fair and equitable treatment. As our future communications with the Government must necessarily be many and frequent, I look forward hopefully, as do also the Board, to receive the same support and cordiality in working which we have hitherto done, and which will tend largely to promote the efficiency of the service in which both the Government and ourselves are so deeply interested. The cable work is now progressing as rapidly as it is in our power to make it, and we look forward hopefully to its being completed at an early period. Nothing that we can do is being left undone to promote the rapidity of the work in hand and its completion. We have appointed the eminent firm of engineers, Messrs. Clark, Ford and Taylor, whose names are a sufficient guarantee that the work will be well and carefully done, and the tests hitherto of the working of the cable have been very satisfactory. The Government have also appointed the principal electrician of the Post Office to supervise the work, in addition to our own engineers, and therefore I think there is sufficient guarantee that nothing will be left undone that can be done to make a good and excellent cable. There have been little unforeseen delays in the manufacture of the cable, which, however, have all been overcome; and, as I have already said, the work is now progressing as rapidly as we can make it. We are now in communication with the Government with respect to the points where the ends of the cable should be landed, both at Halifax and Bermuda. It is necessary that the cable should be laid under the protection of the guns of the fortresses in both places, and that we should be placed in communication with the Governor of Bermuda and the officers commanding the troops at Halifax with that object. Of course until we receive that communication we cannot say exactly where the cable will be landed. The Government have in the island of Bermuda a very admirable system of telegraphy, and there is a private firm of telephony. That will ensure communication right through the island, and be the means of communication with the mainland, and within the reach of everyone. We expect a very extensive traffic from Bermuda. The climate there is remarkably fine in the winter, and the island has hitherto been the resort of Americans to a very considerable extent, but owing to the fact that there has been no telegraphic communication, the island has been left out in the cold. Business men do not like running away from their business, and taking a voyage of three, or perhaps four days, before they can communicate with the mainland, and being cut off from business; but that difficulty will be entirely overcome when we have this cable laid. That necessarily would largely increase our traffic; but, besides that, there is the strategical inportance of Bermuda, which, as you know from the map, is on the same parallel of latitude as Madeira. Owing to the increase in the visitors, I think the traffic will undergo great augmentations. I do not know any island which affords a more desirable residence than Bermuda. It was my fortune when in Her Majesty's Navy to spend a winter there, so I can speak *ex cathedra* of the excellence of the climate and of the geniality and kindness of the natives of the place. They have looked forward with great anxiety and eagerness to this cable being laid, and I think they will be greatly pleased when they find as the result of this meeting that the cable is in process of manufacture. In addition to that, Bermuda also wants this cable communication established with the mainland, as the island will then become a great port of call for steamers. It is also in contemplation by a Canadian Company to erect a weather interpreter on the island, and that will be very important for Europe. Bermuda is 700 or 800 miles from the mainland. It has hitherto been a rendezvous of the fleet, and it possesses a dock, and it is also a very important coaling station as well. That, I take it, will bring a large amount of merchant shipping to the island to report progress and make other communications with Europe. They now run from New York. The steam communication between New York and Bermuda is in fine weather 60 hours—it may be done in three days in fine weather. I look forward hopefully that we shall have a very grand account to make to you at our general meeting after the cable is laid. I think I have given you all the information in my power, but I shall be happy to answer any question.

Replying to questions put by Messrs. Dunlop, Fenwick and Gilkison,

The CHAIRMAN said that 200 knots of the cable were already made. They looked forward to the completion of the cable certainly before the end of the year. The Government would only pay the subsidy when the Company passed the first message through the cable. Meantime the debenture interest would be paid. As soon as possible steps would be taken for giving a market value to the shares. They were to a certain extent bound to complete the cable within a certain time, but they had no doubt they would receive the same consideration from the Government as they had hitherto received if it was not completed by the time. The contractors were bound to deliver the cable in a certain time. As he had said, he expected to have the cable shipped and laid before the end of the year. That would meet their contract with the Government. They had no fear about the contractors not fulfilling their contract by the time specified.

The proceedings then terminated.

NEW COMPANIES REGISTERED.

THE ELECTRIC WIRING AND FITTINGS COMPANY (LIMITED).—Registered by Davidson and Morris, 40 and 42, Queen Victoria-street, E.C., with a capital of £5,000 in £1 shares. Objects: To carry on the business of manufacturers of, and to buy, sell, hire, let and deal in dynamos, mains, batteries, lamps, &c., and generally as electricians and mechanical engineers. There shall not be less than three nor more than five directors. Qualification, being a shareholder. Remuneration to be determined in general meeting.

WILLIAMSON ELECTRICAL AND ENGINEERING COMPANY (LIMITED). Registered by Needham, Parkinson and Slack, 10, York-street, Manchester, with a capital of £5,000 in £10 shares. Objects: To commence, carry on, continue and develop either in New South Wales or elsewhere the business of electrical and general engineers. The regulations of Table A, with slight modifications, apply.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended September 6, 1889, amounted to £3,048.

COMMERCIAL CABLE COMPANY.—A Reuter's telegram from New York says that this company has declared a dividend of 1½ per cent. for the current quarter.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 6, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £1,911.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this company for the half-month ending September 15 amounted to £2,034, as compared with £2,490 in the corresponding period last year, a decrease of £456.

In re **ELLIOTT LIVERSEDGE.**—The first meeting of the creditors of this debtor, who carried on business at Huddersfield, was held on Tuesday, the 10th inst. The statement of affairs showed liabilities amounting to £194. 16s. 4d., and assets (after the deduction of £11. 11s. 8d. for preferential creditors) reaching £111. 11s. 10d., leaving a deficiency of £83. 4s. 6d. The cause of failure alleged is a breach of contract. The assets consist of household furniture, upon which a claim has been made under a bill of sale for £30 (alleged to be advanced), executed on the 20th August; and tools, implements, and book debts.

NOTICES OF REMOVAL.—Messrs. Englebert and Co., the well-known lubricant manufacturers, inform us of their removal from their old premises at 70—71, Bishopsgate-street, to more commodious premises at 44—47, Bishopsgate-street Without, E.C.

———Messrs. Rashleigh Phipps and Dawson, now of 185—191, Gray's Inn-road, W.C., announce their approaching removal to larger premises, and that on and after September 30 their address will be 53, Berners-street London, W. The works are at Wells-mews, W.

THE NON-CONDUCTOR OF ELECTRICITY.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

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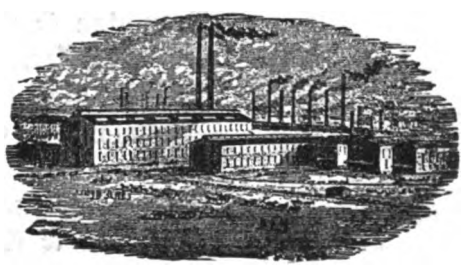
Sold in sheets, 5ft. 6in. by 2ft. 6in., varying in thickness from 1-50in. to 1in.



FACTORY.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Sept. 18, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 18, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	15/0	Anglo-American	53 54	4 12 7	Jan., Apr., July, Oct.	53	52
2,614,820	Stock	30/0	Do. Preferred	90 91	5 9 11	,, ,,	89⅜	88⅝
2,614,820	Stock	...	Do. Deferred	18 18½	...	February	18⅛	18⅛
130,000	£10	5/0	Brazilian Submarine	13½ 14	5 14 4	Mar., June, Oct., Dec.	13⅜	13 7/16
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10⅛ 10⅜	5 16 2	Jan., Apr., July, Oct.	10⅞	10⅛
380,000	10	5/6	Eastern	13⅜ 14	4 12 10	,, ,,	14	13⅜
70,000	10	3/0	Do. 6 per Cent. Preference	15⅛ 15⅜	3 16 2	,, ,,	15⅝	15 7/16
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	109¼	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	108	107
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13 9/16	13⅜
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	105⅞	104½
179,177	10	4/0	Globe Telegraph and Trust	8⅜ 8⅝	8 7 3	Jan., Apr., July, Oct.	8⅝	8⅜
178,992	10	3/0	Do. 6 per Cent. Preference	14⅞ 15⅛	3 19 4	,, ,,	15	14⅞
150,000	10	5/0	Great Northern	15⅜ 15⅝	4 15 3	Jan., July, and April	15½	...
17,000	25	37/6	Indo-European	40 42	6 1 6	April and October	...	...
9,000	8	8/0	Reuter's	6⅝ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	9 7/8	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101	...
90,000	10	5/0	West Coast of America	10¼ 10⅜	5 2 4	January and July	10½	10⅜
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	126	...
88,321	10	nil.	West India and Panama	2¼ 2⅜	...	...	2⅜	2 5/16
84,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12 5/16	12
4,669	10	*	Do. 6 per Cent. 2nd Preference	14½ 15¼	...	...	15¼	...
45,181	15	9/0	Western Brazilian	10⅜ 11¼	6 10 4	March & September	11¼	10 1/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	5/16 7/16	3 15 0	...	...	...
55,000	5	...	United River Plate	5¼ 5½	...	January and July	5¼	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3⅛ 4	...	...	3⅞	3⅝
23,692	5	2/0	Do. (fully paid)	4⅜ 5	...	February & August	4⅞	...
79,934	5	...	Swan United (£3. 10s. paid)	4½ 5	...	...	4⅝	4 1/16
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	45⅝	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19¾	...

* No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 593.—Vol. XXIII. FRIDAY, SEPTEMBER 27, 1889. Price Fourpence.

NOTES.

A few days since we had the pleasure of inspecting the Electric Lighting Station at Bradford, which, as our readers will be aware, has just been completed by Messrs. Siemens Bros., under a contract with the Corporation of the town. As the first Municipal undertaking of its kind, this station possesses a special interest, and its practical and financial success will doubtless incite many other Municipalities, at present wavering in the balance, to follow suit. For this reason it is, to a certain extent, to be regretted that as a simple low-tension system, this installation, fine as it is in many respects, does not afford an adequate illustration of modern methods of electrical distribution. Under the existing local conditions—by which we refer not only to the topography and the requirements of the town, but also to the opinion maintained by electrical amateurs on the Council—we are, however, prepared to believe that Mr. Shoolbred (the consulting electrician) was, on the whole, justified in recommending a low-tension system pure and simple. We trust that the success of the existing installation of 360 E.H.P. will be sufficient to induce the authorities to see the wisdom of adopting in their contemplated extensions one or other of the available systems by which the radius of distribution can be so widely extended. In our next issue we intend to give a full description of the station as it at present exists.

Since the Bradford Corporation is charging only 5d. per unit the early financial success of their undertaking on the present small scale of operations will in all probability largely depend upon the extent of the day service. It is anticipated, however, that the demand for motors will, before long, become an important feature of the supply. Ultimately, it is hoped that the tramway lines, which are the property of the Corporation, may be worked by electricity, but this is, of course, quite out of the question under the present *régime* of 115 volts.

During the recent visit of the British Association to Newcastle, several of the members visited the station of the Newcastle-upon-Tyne Electric Supply Company, which is now in course of erection. The Company has been fortunate in securing several acres of land admirably situated for the purpose. The North-Eastern Railway runs alongside; at a short distance in one direction is the chief business quarter of the town, whilst in the opposite quarter is one of the most important residential districts. The plant now being erected consists of two Robey compound horizontal engines with automatic expansion gear. Each engine is capable of working at 200 indicated horse-power, and has a 12ft fly-wheel driving by ropes a Mordey alternator for an output of 100,000 watts, running at 430 revolutions per minute. Each alternator has a Victoria exciter driven direct on the shaft and capable of exciting two of the larger machines if required. Owing to the very extensive network of underground telephone lines which Newcastle already possesses, the system of underground mains to be adopted for the alternating currents has required special consideration. A method possessing several novel and interesting features has been worked out by Mr. A. Heaviside (Consulting Electrician to the Company), in conjunction with Mr. Jackson (the Company's Electrician); at a later date we hope to give the details.

Amongst the several Committees of the British Association appointed by Section A is one "On the Magnetisation of Iron," and, as may be readily imagined, its first report was anticipated with a good deal of interest. One naturally looked for a thoroughly competent survey of the present state of knowledge of the subject, in which the many important contributions of recent years would be brought together, and, so far as possible, co-ordinated and generalised. Instead of this we were disappointed and surprised to hear nothing more novel or edifying than a brief historical survey of the discovery of recalescence, and its connection with the magnetic properties of iron. Not a word was said as to the recent researches of Dr. Hopkinson in this particular direction. The report, in fact, cannot be said to present any features of scientific or historical interest which are not already perfectly familiar to the scientific world, and we regard it as quite unworthy of a Committee of the British Association.

To some non-technical journals the laying of a main is apparently synonymous with the lighting of the street, and the operations in the Strand and elsewhere have called forth a good deal of ecstatic writing on the subject of the "new illuminant." "London night-by-night is to be no more; it is to be one continual round of daylight." "The burglars and street brawlers," says another journal, "have had matters their own way far too long. Therefore we hail the prospect of increased electric lighting as a positive boon." Considering that the City Commissioners of Sewers, who alone in the metropolis have seriously taken the question of street-lighting into con-

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sideration, are in their normal state of adjournment, we are afraid that the "terrible nights of November" will arrive without the "positive boon."

Since writing the above we see that the City Commissioners have returned to the scene of their labours. On Tuesday the debate on the report of the Streets Committee was resumed, and resolved itself without delay into a wrangle as to whether or not the report should be printed and circulated, the proceedings terminating with the inevitable motion of adjournment. For our own part we cannot but concur in the remark of Mr. Deputy BEDFORD, that there has been more than enough consideration already in this matter, and that the City Commissioners bid fair to become "the laughing stock of the whole metropolis."

MEANWHILE, the Vestry of Paddington, which has run the City pretty close in the matter of shilly-shallying, has at length decided to leave electric lighting in their own district entirely to private enterprise. This is, no doubt, the wisest decision they could have come to, and if they had seen things in the same light six months since the practical arrangements would doubtless by this time have been in an advanced stage; as it is, nothing can be done for many months to come.

THE system about to be introduced in the Netherlands telegraph service of classifying telegrams under three heads, namely, "urgent," "ordinary," and "slow," prevails in several continental states, and has been more than once recommended for this country. No good case can be made for such an invidious classification with us, although in some countries its adoption may be regarded as a very desirable reform. The truth is, "urgency" is demanded only where slowness is the rule. In England all telegrams are treated as urgent, and transmitted at a speed which could hardly be accelerated; and the effect of giving undue preference to higher priced messages would be to lower the general average rate of transmission all round. Elsewhere the effect may be to expedite a few messages without materially affecting the general slowness.

THE reduction of telephone rates in France by one-third, consequent upon the acquisition of the service by the French Government, will supply a fresh argument for those who advocate a similar course in respect to the British telephone companies. In the Postmaster-General's Annual Report no particulars are given with regard to the Post Office telephone system, and we may therefore assume that it has not made much progress as a competitor in this line of business. For similar reasons, probably, the particulars under the head of Private Wires also show that the revenue derived from this source increases at a very slow rate indeed. Last year it amounted to the respectable sum of £125,222; but in 1885-6 it was actually greater than it is at present, the rentals having been reduced in 1886-7.

IN an investigation published last year, KUNDT gave a number of results which appeared to indicate the existence of a relation between the velocity of light in metals and their conductivity for electricity and heat, and he pointed out that if this were really the case the velocity of light in a metal would necessarily vary with the temperature. He has recently investigated this point, and finds that the velocity of light in a given metal is inversely proportional to the absolute temperature, which is exactly the same relation which LORENZ, ARNDTSEN and BENOIT have found to exist between the absolute temperature and the electrical conductivity. The results obtained appeared to show that the velocity of light at varying temperatures is, in a given metal, directly proportional to its electrical conductivity.

ON the subject of our recent remarks about ironmongerdom, a correspondent, who appears to have excellent opportunities of judging, informs us that so far from the day having, as we had hoped, quite gone by when any bellhanger or tinker was considered competent to wire a house for electric lighting, the men who are called in to do this kind of work are often not even respectable tinkers, but more commonly gasfitters, than whom no class of artisan can be unfitter for the work he takes in hand, and whose attempts at making a joint are everything that Mr. HEAPHY declares it ought not to be.

SOME valuable results in connection with the treatment of Leclanché cells have recently been arrived at by Herr MÜLLER. He finds that it is a good plan to cover the zinc rod at the point of contact with the air by a piece of India-rubber tubing an inch or so in length. The rate of loss of zinc is often twice as great at or near the surface of the liquid if it is exposed to the air. It is advantageous to amalgamate the zinc, as this prevents the crystals of zinc oxide from adhering to the rod, and thus reducing its effective surface. The solution of sal ammoniac should not contain more than 2 or 3 per cent. of the salt, which is a much weaker solution than it is customary to employ in this country.

THE following somewhat novel demonstration of a well-known theorem has been sent us by an ingenious correspondent, who alleges that he found the document in an omnibus:—

"If a conductor be charged by an excited body, the conductor will repel the body with a force varying inversely as the amount of the charge which the conductor has not received. The total amount of the disturbance will depend partly upon the density of the body and partly upon the resistance of the conductor. If the conductor and the body be carefully separated, it will be found that the body is positive and the conductor negative. Now, let a small disc of copper (or better, of silver) be made to pass from the body to the conductor, and the state of strain will be immediately relieved. If any excess charge should afterwards be found in the exterior coating of the conductor, the conductor may be discharged; but it will usually be found that the amount of charge upon the conductor will be rapidly diminished in the presence of moisture. The cause of this phenomenon may be explained as follows:—Suppose the conductor to be brought into the neighbourhood of a gilded bar; the conductor will be seen to be powerfully attracted. A small disc of copper is then made to rotate rapidly for about a second. After this the conductor will probably part with a portion of the charge, and the moisture will be rapidly absorbed."

DR. LODGE'S article on the Electrical Papers in Section A is unavoidably held over.

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The Gibraltar-Tangier Cable.—Telegraphic communication across the Straits of Gibraltar is now restored.

University College, Dundee.—The Autumn Session of this College opens on October 7th. For further particulars see our advertisement columns.

The Telephone in Russia.—The Vienna correspondent of the *Standard* says that a telephone line is to be erected between St. Petersburg and Moscow.

The Strike at the Telegraph Construction and Maintenance Works.—The strike of the *employés* of this firm came to an end on Monday, the men's demands being conceded.

Drumcondra.—A splendid palace is now being erected at Drumcondra, a Dublin suburb, for Dr. Walsh, Archbishop of Dublin. The whole building will be illuminated by the electric light.

Electro-Physiology and Therapeutics.—A course of ten weekly lectures and demonstrations on these subjects will be given at the Institute of Medical Electricity, by Dr. Arthur Harries and Mr. Newman Lawrence. The first lecture will be given on October 8th.

The Telephone in Australia.—Telephonic communication is being steadily developed in Australia, the receipts having increased largely in Victoria during the past twelve months. The first long-distance line between Victoria and Geelong is now nearly ready for opening.

Osaka (Japan).—A consular report from Osaka, Japan, draws attention to the introduction of the electric light in that city during the past year. The company is composed exclusively of Japanese, and has a central station fitted with the best American machinery and plant.

Asbestos Reef in Griqualand West.—Recent advices from the Cape state that asbestos of the finest qualities and in large quantities has been found on the land belonging to the Griqualand West Copper Syndicate. Four distinct reefs are reported to have been struck, running four feet wide.

Personal.—On the occasion of Mr. Edward Gimingham (brother of the resident superintendent of the Edison-Swan factory) coming of age, and being appointed to a responsible position in the factory, he was presented with a handsome Wortley writing desk by the officials connected with the works.

The Electric Light in Pearl Fishing.—The project for employing the electric light for facilitating work at the Pearl Banks off the coast of Tinnevelly, has been abandoned by Government, after consulting the Fisheries Departments of England, Scotland, the United States and Western Australia.

Obituary.—The death occurred at an early hour on Thursday last week at Rochfort Tower, South Norwood, of Mr. Cyrus Legge, J.P. for the borough of Croydon. The deceased, who was about 76 years of age, was one of the promoters of the Atlantic Cable, and was connected with many other large undertakings.

Barnsley.—Last Tuesday a meeting was held at Barnsley to consider the action of the local gas company in increasing the price of gas. It was unanimously resolved to present a requisition to the Mayor to convene a public meeting in the Public Hall to consider the desirability of allowing one or more electric lighting companies to enter the town.

Tenders Wanted.—The Rural Sanitary Authority of Wimborne, Dorset, invite tenders for public lighting. Tenders are to be in by October 16th. Particulars can be obtained of Mr. F. H. Tanner, Church-street, Wimborne, Dorset.—Tenders are invited by the Postmaster-General for 8,041 red fir telegraph poles. Tenders are to be in by the 21st October. Particulars of Mr. C. E. Stewart, controller, Telegraph-street, E.C.

University College, London.—The 1889-90 Session of this College commences on October 2nd, and junior and senior courses on electrical technology will be held as usual by Dr. J. A. Fleming. These courses are intended to provide instruction in the subject of applied electricity, and will be supplemented by visits to various central stations and works. The list of subjects dealt with in each class is of a very comprehensive character.

Singular Interruption to a Cable.—An interruption lately occurred upon the cables of the Western and Brazilian Telegraph Company on the coast of Brazil. The cable was repaired on the 17th inst., and it was found to have been broken by a large whale. The cable was embedded in the whale's body for about 50ft. We understand that this is the second instance of a similar character.

Chester.—A special meeting of the Chester Town Council was held on Wednesday last week, for the purpose of considering a recommendation of the Watch Committee that application should be made for a Provisional Order authorising the supply of electricity for public and private purposes by the Corporation. The recommendation was carried unanimously, and the Watch Committee were empowered to take the necessary steps to give effect to the resolution.

Sale by Tender.—The sale is announced of the stock-in-trade, plant and patent rights of Luther Hanson and Company (Limited), of North Bridge Electrical Works, Halifax. There is a considerable stock and plant, and the interest in three patents. Tenders must be sent on or before October 21st to the Official Liquidator, James Duff, Chartered Accountant, Barum House, Halifax. Further particulars will be found in our advertisement columns.

The Measurement of Radiant Energy.—Those of our readers who had not the privilege of hearing the admirable lectures by Mr. Vernon Boys on "Instruments for Measuring Radiant Energy," will be glad to know that they are now appearing in the *Journal* of the Society of Arts, the first lecture having been published on September 20th. Many instruments described are of an electrical character, and the whole subject is treated with great ability and comprehensiveness.

An Electrical Offertory-Box.—"An electrical offertory-box, which rings a bell whenever a button or a piece of tin is deposited in it, is the latest thing 'over the way.' Mr. Edison should adapt his phonograph to the same purpose. Then, when the stingy millionaire deposits his niggardly contribution, the box would announce in clear nasal tones:—'Dives A. Crœsus resides on Fifth Avenue, and has an income of 50,000 dollars. He has given ten cents. Next, please.'"—*Globe.*

Leamington.—A special meeting of the Town Council was held last Monday for the purpose of considering the Lighting Committee's recommendations with regard to the lighting of the Parade by Bray's burners. Mr. Fell, in the course of the discussion, announced that the Electric Lighting Company had intimated that they were prepared to give arc lights with overhead special cables, which would ensure an efficient and cheap light. It was decided that the question of the lighting of the Parade be referred back to the Committee.

Falmouth.—At Falmouth Local Board, on Thursday last week, the Lighting Committee reported that they had considered the applications from certain electric lighting companies. The Committee reported that in their opinion a sub-committee should be at once appointed to watch any Provisional Order that may be applied for having for its object the use of the electric light within the jurisdiction of the Local Board. The report was unanimously adopted, and the Lighting Committee were asked to act in the matter.

The Shaffer Automatic Sprinkler and Fire Alarm.—A demonstration recently took place with a combined electrical fire alarm and automatic sprinkler, which has been devised by Mr. Shaffer. It consists of a small hollow iron box, filled, as usual, with a material which expands under heat, and which in its expansion first closes an electric alarm circuit and next operates a compound lever, which opens the sprinkler, and admits the water through a spreader on to the fire. It is stated to be in extensive use in the United States.

University College of North Wales.—We have received the calendar of this institution for the year 1889-90. The Physical department is under the charge of Prof. Andrew Gray. A special course of experimental work in electricity and magnetism will be begun in October, the course consisting of a series of exercises in (1) Electric and Magnetic Measurements; (2) Practical Applications of Electricity. The new physical and chemical

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laboratories of the College have an area of 120ft. by 80ft., and contain a room specially devoted to electrical measurements, constructed without iron to insure a uniform magnetic field.

A Portable Extension Ladder for Electric Light Work.—The recent additions to the electric lighting arrangements at the British Museum has necessitated the introduction of a telescopic combined step-ladder platform, which has been constructed by Messrs. J. H. Heathman and Co., of 11, High-street, Bloomsbury. It consists of a double step-ladder mounted upon rubber-tired wheels to pass through a doorway 4ft. wide × 11ft. high, and the base is 6ft. long. By means of a twin rope a step-ladder, with platform sufficiently large for two men to stand upon and provided with guard rails all round, is made to rise to a height of 18ft., while the whole is so light as to be wheeled and turned about by one man.

Royal Victoria Hall.—We are glad to learn that the building of the Morley Memorial College, in connection with the old "Vic.," is rapidly approaching completion. On Thursday last a *soirée* of the past, present, and future students of the College was held in the large museum and library. This large and lofty room is 77ft. long by 34ft. wide, and being lighted from above will be eminently suitable for exhibitions of pictures. The College will contain fifteen class and common rooms of various sizes. The first science lecture at the hall will take place on October 1, when Prof. A. W. Rücker will discourse on "Underground Mountains." Prof. Henry Morley will take the chair, and will address the students on the opening of the College, after which the prizes and certificates won during the last session will be given.

The Definition of "Effective Current."—A Correction.—In the report of the proceedings of the Paris Congress which appeared in our issue of September 6th, a misprint occurred in connection with the definition of "effective current" and effective E.M.F., which it is the more desirable to correct since these terms have now been adopted by the British Association. On p. 454, 2nd column, lines 4 and 9, the expression for the effective current should be written

$$\sqrt{\frac{1}{T}\int_0^T i^2\,dt}.$$

Similarly, in line 10, the effective E.M.F. should be

$$\sqrt{\frac{1}{T}\int_0^T E^2\,dt}.$$

Is Electricity Subject to Duty?—Solicitor Hepburn, of the Treasury Department at Washington, says the *Electrical Review* of New York, has been called upon to decide an interesting question in regard to the introduction into the United States of electricity generated in a foreign country. It seems that an association of gentlemen has established an electrical plant at Niagara Falls on the Canadian side, and propose to extend their wires to Buffalo for purposes of illumination, &c. Before doing so, they desire to know whether the electrical current thus transmitted into the United States would be subject to duty or other tax. It is believed that the solicitor will evade the question by informing the persons interested that it is contrary to the rules of the office to answer hypothetical questions of this character.

Fareham.—A public meeting was held at Fareham last week to consider the question of forming a company to supply electricity in the district. The meeting was addressed at some length by Mr. J. Blake, who said that they could start a company with a capital of £5,000. The works and plant would cost about £4,000, and this would include all the working plant. The annual expenses would be about £600 or £700, whilst he estimated the receipts to be about £1,000. After the matter had been fully debated, papers were passed round the room for those present to fill in, stating the number of shares they were willing to take. Mr. Blake remarked that already £1,000 had been subscribed by personal friends. Several of the papers were then handed to the chairman, and Mr. Blake intimated that in a few days a prospectus would be issued.

The Burton Electric Heater.—The Burton Electric Heater which is now being introduced by the Burton Electric Company, of Richmond, Va., for railroad heating, house warming, cooking, merely consists of a cast-iron case, enclosing some resistance coils, which are covered with dry, powdered clay, for the purpose of absorbing the heat from the wires, and thus preventing them from burning out. The current supplied to the heaters has a potential of 80 volts, and each heater uses about 2½ amperes. It has been found by experiment that such a current raises the temperature of a heater about 200deg. Farenheit. These heaters, once constructed, are expected to be permanent fixtures, requiring no further attention. The moderate rise of temperature is thought to preclude all danger of fire, and it is impossible for the resistance wires to be melted unless the surrounding clay is raised to the melting temperature of the wire.

The Sunbeam Lamp.—The Members and Associates of the British Association had a good opportunity of judging of the excellent effect of "Sunbeam" incandescent lamps for lighting large halls at the *conversaziones* which took place at the recent meeting at Newcastle. The three principal rooms and the vestibule of the museum buildings where they were held were brilliantly illuminated by 300 candle-power Sunbeam lamps, suspended from the ceiling. Considerable interest was excited on the second evening by the exhibition of a Sunbeam lamp of 3,000 candle-power. This, we believe, is by far the largest incandescent lamp ever made, and its effect was very brilliant. We understand that the manufacture of these very large lamps has been rendered possible by recent improvements introduced into the manufacture by Mr. John W. Edmundson, the manager of the Sunbeam Lamp Company's works.

Lectures on the Design of Dynamos.—We have much pleasure in calling attention to the "special course" of lectures announced in our advertisement columns on "The Design and Construction of Dynamo Machines," which will be delivered at the Finsbury Technical College on Monday evenings during the current autumn, commencing on October 7th. If for no other reason than the very low fees charged for the special courses at the College, electrical students have reason to be grateful to the City and Guilds Institute. Prof. Silvanus Thompson, who is going to undertake these lectures, announces that the lectures will be supplemented by exercises in calculation and drawing, to be worked out at home by those attending the class. The syllabus shows that mechanical details of construction, as well as electrical considerations, are prominently treated, and that alternate-current dynamos, motors, and transformers come within the range of the course.

The Finsbury Technical College.—As mentioned in our last issue, the evening classes of the City and Guilds Technical College, Finsbury, reopen on Monday, September 30th. Instruction is given in the Applied Art Department in technical painting, modelling and designing, art metal work, furniture design and cabinet making. Special courses are given for carpenters, plumbers, bricklayers, metal-plate workers, and the building trades generally. Classes are also held for those engaged in electrical, mechanical, and chemical industries. In connection with all the courses of lectures there is a corresponding course of practical instruction in laboratory, workshop, or drawing office. The main object of the College is to impart sound instruction, and to prepare students more for industrial purposes than for examination. The fees vary from 6s. to 30s. for a period of about eight months. Apprentices under 20 are admitted at half fees.

Mr. Edison in London.—Mr. and Mrs. Edison, who have been on a short visit to Sir John Pender, at Foots Cray, visited the Mansion House on Tuesday afternoon, and were entertained at luncheon by the Lord Mayor and the Lady Mayoress. The company also included Lord Brassey, Sir John Pender, Sir James Anderson, Mr. J. S. Forbes, Sir Polydore De Keyser, Colonel and Mrs. Gouraud, the Mayor of Nottingham, and others. Mr. Edison leaves for the United States on Saturday. During his stay Mr. Edison visited the various central stations of the Metropolitan Electric Supply Co., and expressed approval of the arrangements. He also visited the Deptford station of the London Electric Supply Co. On Wednesday, Sir John Pender entertained at dinner at his residence, Foots Cray-place, several

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scientific gentlemen and others interested in electricity. Mr. Edison was the guest of the evening. Among the company were Lord Crawford, Sir George Elliot, M.P., Sir James Anderson, Mr. Spencer Balfour, M.P., Mr. J. Staats Forbes, Dr. Hopkinson, F.R.S., Mr. F. Leyland, Mr. J. Denison Pender, Mr. John Verity, Mr. Preece, F.R.S., and Mr. S. Z. de Ferranti.

Bourganeuf.—In a recent number of the *Comptes Rendus*, M. Marcel Deprez gives some particulars with regard to the transmission of power installation at Bourganeuf, where, owing to the frequent failure of the waterfall in the town itself, it has been found necessary to obtain the power for driving the electric light machines from a fall at Les Jarrauds, nine miles off. The generator has two armatures connected in series, and mounted on the same spindle. Each ring has a resistance of 2 ohms, and revolves between the poles of a separate field-magnet. The generator is belt-driven by a 130 horse-power turbine running at 150 revolutions. The field-magnets are partly excited by a small auxiliary machine giving 90 volts and 20 amperes. The line, which has a resistance of 23 ohms, is of bare 5 millimetre silicium bronze wire. The motor at Bourganeuf is identical with the generator at Les Jarrauds, and, like it, is independently excited, in this case by the electric lighting machines. At the moment of starting, however, the field is excited by the accumulators at the central station. The dynamos, two in number, are of the Gramme type, giving 110 volts and 250 amperes. In preliminary workshop experiments over an artificial line of 30 and 25 ohms resistance, it was shown that for every 100 horse-power developed by the turbine, at least 60 horse-power was available for lighting purposes, the E.M.F. of the generator being between 3,550 and 3,750 volts.

A Railway Signal Device.—Some trials were recently made on the Nottingham Suburban Railway of an apparatus devised by Mr. W. Andrews, of Nottingham, the primary object of which is to afford means whereby the driver of a locomotive may tell exactly how the signals are at particular points on the railway over which his train is proceeding. For the experiments a mile and a quarter of the suburban line, running from Sherwood Station towards Daybrook, was selected. Parallel with the permanent way there was a zinc-covered wooden rail. By means of a brush attached to the foot-plate of the engine the circuit of two dials placed on the weatherboard of the locomotive was established in turns. One of the dials was in the form of a miniature semaphore signal, the other being similar in appearance to a steam gauge dial, and capable of registering distances from a quarter of a mile up to nine miles. An operator was stationed at each end of the line, and when, acting upon a previously arranged code, the signals were put on or taken off, the fact was at once indicated on the engine. By means of the second dial the distance between various points was also indicated. Mr. Andrews is sanguine that his signalling apparatus would prove of the greatest value in foggy weather when the ordinary signals cannot be seen, as at any point from 200 to 400 yards outside the distance signal the driver would be able to tell at once in what position the particular signal might be, and whether he was at liberty to proceed.

Salford.—A special meeting of the Salford County Borough Council was held on Thursday last week, for the purpose of considering the notice given some time ago by the Manchester House-to-House Electricity Company of their intention to apply for a Provisional Order.—The Mayor moved that the Corporation should apply for a Provisional Order authorising them to supply electricity for public and private purposes within the area of the county borough.—The Town Clerk remarked that if the Council adopted this resolution it was not absolutely necessary that, having got the power, they should carry the scheme into effect. It was his intention to apply to the Manchester House-to-House Electricity Company to withdraw their notice, and the Corporation having taken the necessary steps to apply for a Provisional Order, he hoped they would withdraw it, and so save the expense of Parliamentary proceedings.—Mr. Joseph Corbett asked if the Council were to understand that it was intended to take up the matter of electric lighting in a practical way, or were they to understand that the proposed application by the Corporation was merely to be made for the purpose of hindering electric lighting?—The Mayor said that if the application was granted it would enable the Corporation, as gas makers, to supply electricity if it was thought desirable, and they should also be placed in a position to defend themselves against any outside company which might want to step in.—Mr. J. Snape was of opinion that the proposal made by the Mayor was an advisable one to follow, if only to prevent anybody else stepping in. As to the future of electric lighting, that was a matter for further consideration. After the Corporation had got powers, probably the gas or a special committee would go into the whole matter and report to the Council.—The resolution was carried unanimously.

Calcutta.—In our issue of August 23rd we mentioned that Messrs. Octavius Steel and Co., agents for Crompton and Co. (Limited), had obtained the sanction of the Port Commissioners to light the jetties, the Hooghly pontoon bridge and wharves with the electric light. The following are some additional particulars with regard to the scheme:—The company agree to supply 42 arc lights, each of 2,000 candle-power, at a cost of, for an average of nine hours per night, two annas per light per hour, or Rs.17,293 per annum, as compared with Rs.15,306, the amount now paid for lighting by gas. The company undertake to fix connection boxes at 30 positions within the jetty transit sheds, and on the jetty sheds, these positions to be occupied by movable arc lights placed as required to suit the convenience of such vessels as discharge or take in cargo at night. The vessels lying along the wharves and jetties will be supplied with movable arc lamps, and for the use of the office currents will be supplied to incandescent lamps. Messrs. Octavius Steel and Co. have been allotted two cottahs of land at Pathoreah Ghaut. It is necessary to mention, says *Indian Engineering*, to whom we are indebted for the above details, that the Port Commissioners of Calcutta in adopting these measures are only following in the wake of the Harbour Trusts of Karachi and Rangoon; further, that, as already intimated, Messrs. Octavius Steel and Co. have placed proposals before the P. W. D., Bengal, for lighting the Calcutta *maidans* with electricity. This latter scheme does not appear to meet with that appreciation which would be expected for an acknowledged and needed public improvement in the metropolis of India—particularly when one of the alternate offers involves no additional expenditure, but secures many advantages over the present gas lighting.

The Cost of Street Lighting in New South Wales.—The following information respecting the cost of street lighting by electricity in the municipalities of Tamworth and Young was supplied by the councils of those municipalities, and was read for the information of members of the Municipal Association of New South Wales, at the July meeting, at Sydney:—At Tamworth, the first cost of plant, in which all running machinery is in duplicate, was £3,000. The contractors agreed to work the installation for a period of 12 months for the sum of £470, which did not include interest. The wires covered a distance of about eight miles. There were 73 lanterns, each lantern having two or three 20 candle-power electric lamps. The engines were twelve horse-power nominal. Each dynamo was capable of giving 250 20 candle-power lamps. The incandescent lamps were, in the opinion of the Council, very suitable for street lighting. In addition to the incandescent lamps there are three 2,000 candle-power arc lamps in the main street. At Young the first cost was £7,000; average working expenses, £1,100 for first year, to be paid contractor for providing 1,500 lights if required. Length of wires, 11 miles of main cable for streets, and from thence leading to street lamps and houses about seven miles. Present number of lights and their power, 104 16 candle-power lamps for streets. Capacity of plant, 1,500 16 candle-power lamps. Size of engines, two 75 horse-power, by Fowler, of Leeds. Three 500-light Thomson-Houston alternators and two dynamo exciters. The light was found to be clear and steady. The plant has been examined by the inspector of the Underwriters' Association, and by him pronounced complete, and no exception could be taken to the installation. The light a mile distant from the engine is as good as that near. The annual charge made by the Council to private consumers for use of light was 30s. first light, next four 25s. each, next five 20s. each, next five 15s. each, all others 10s. each.

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THE BIRMINGHAM EXHIBITION.

The Exhibition at Bingley Hall is now in a state far nearer completion than when our previous notice was written, though some of the stands remain yet in an unfinished state.

We are sorry to find that the telpher line has been stopped on account of complaints made by neighbouring residents of the noise and vibration which is caused. We understand that efforts are being made to get the train in operation again, and we sincerely hope that the persons on whom the inconvenience falls may be induced to give their consent to its re-starting and running for the short time during which the Exhibition will be open. We must confess to some unpleasant feelings on seeing the telpher locomotive with some rough blocks of wood secured to the lower part, apparently to prevent it from swinging against the supporting posts when going round the curve at the end of the Winter Garden, and the motor covered in by a battered, unpainted tin case. Surely it is worth while to put on a respectable iron case and use a little paint to prevent the public from thinking that Electrical Engineering work is still carried out by scientific enthusiasts, who lack a due regard for appearances, not to say security.

Crompton and Co.—One of the most interesting exhibits in the Hall is that of Messrs. Crompton, who have an electric crane in operation. A description of this crane has already appeared in our columns (*The Electrician*, November 30, 1888), one or two very slight alterations only having been made in the design since then. The chief of these is the replacement of the hand lever, which was employed to throw the travelling motion in and out of gear, by a hand wheel and screw which enables the attendant to leave this motion in gear and give his attention to the hoisting and swinging motion. We were much struck by the ease and precision with which the operator governed the various motions of which the crane is capable, viz., travelling horizontally, swinging round on its centre, and hoisting or lowering. The transition from one motion to another was performed with far greater rapidity and less exertion on the part of the operator than in the case of steam cranes. The crane is constructed to lift 30cwt. at a rate of 80ft. per minute. The reason why an electric crane can be manipulated so completely without loss of time is that the motor can be kept always running. and the changes made entirely by means of friction clutches. This arrangement is made possible by the fact that an electric motor will not "run away," even if the full load is suddenly thrown off, as an ungoverned steam engine would do under the same circumstances. Messrs. Crompton also show on their Stand one of their new "Trade" dynamos for 110 volts and 162 amperes when run at 1,000 revolutions per minute. They are also just getting into operation a 24in. search light. A No. 30 Crompton dynamo, shunt-wound, and capable of running 412 60-watt lamps when driven at 550 revolutions per minute, is fixed in the Machinery Hall, and supplies current to the crane and the lamps in the Swan Company's stand, and, in addition to other lighting, to three motors of Messrs. Crompton's make of the upright magnet single-bearing type, which are driving exhibits at various parts of the hall. One of these, a 3 horse-power motor, drives a large Blackman air propeller, situated at the entrance to the coal mine; a second, a 1 horse-power motor, drives some pen-making machinery at the stand of Messrs. Turnor, pen-makers, of European Works, Birmingham; and the third, also of 1 horse-power, drives a small electro-plating machine and some polishing buffs, &c., at the Stand of Messrs. W. Canning and Co., electro-platers, &c., of Birmingham.

Lacombe and Co.—The exhibit of Messrs. Lacombe and Co. is worthy of notice, though it is not as imposing as many of the others. They show specimens of the different forms of carbons manufactured for various purposes—lamps, batteries, &c. Among other things are two pieces of carbon, used as far back as 1862, with the Holmes apparatus in the Dungeness Lighthouse. The newest forms of fluted carbons are also shown, including two large ones that have been partially used in St. Catherine's Lighthouse this year. These, as also the two historical specimens above mentioned, have been lent to the firm for exhibition by Sir J. N. Douglass, the chief engineer of Trinity House. Nearly all the arc lamps running in the Exhibition are using carbons manufactured by this company. We may also notice an improved form o Leclanché cell (Fig. 1), of which an illustration is given showing the internal arrangements. The zinc rod Z is in the centre, surrounded by the porous pot B; next to this is the depolariser M M, and on the outside the carbon cylinder A. This cover and the porous pot are held in position by the cover and base C C. The terminal N is fixed to a metal collar in contact with the carbon. It is claimed that this arrangement lowers the internal resistance, prevents "creeping," and effects complete depolarisation, because the hydrogen—at every point of the surface of the electrodes—must cross the entire mass of the depolariser before being able to reach the carbon electrode. A further advantage is gained by using a new exciting salt

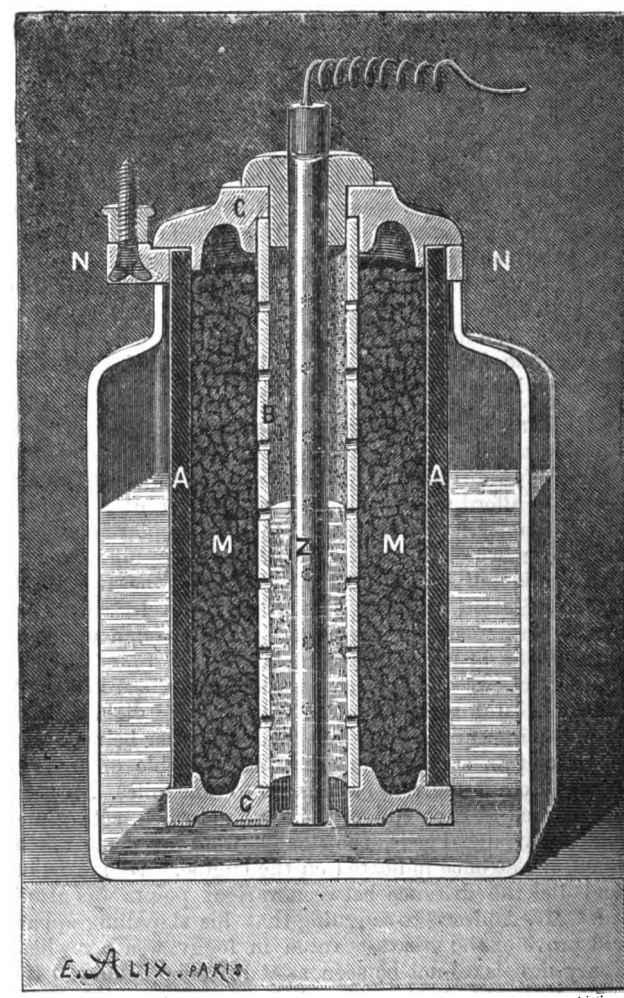

Fig. 1

instead of ordinary sal ammoniac, which prevents the formation of the crystals and allows the zinc to be uniformly consumed throughout the whole of its length.

J. G. Statter and Co.—Messrs. J. G. Statter and Co. (Limited) show one of their mark D C, type A, dynamos, driven by a 4 horse-power Crossley gas engine, and lighting their stand by 22 16 candle-power incandescence lamps and two parallel arcs. The machine gives 40 amperes and 60 volts with a speed of 1,400 revolutions per minute. They also exhibit a 1½ horse-power motor, mark M B, type A, which is of their well-known type, with single upright magnet and pole-pieces bending over to one side. The motor is designed to run at 1,100 revolutions with 60 volts pressure. The motor of the telpher locomotive is also of Messrs. Statter's manufacture, and is of 4 horse-power. In the Machinery Hall Messrs. Statter have one of their constant-current 10 ampere dynamos. The machine is driven from the main countershaft, and is to run four of their "Workshop" type arc lamps in the bay adjoining the Winter Gardens, and also six Bernstein lamps in series with the arcs in the Machinery Hall.

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BULLER, JOBSON AND CO.—One of the most striking exhibits at Bingley Hall is undoubtedly that of Messrs. Buller, Jobson and Co., the well-known insulator makers. This exhibit consists of a huge square standard (Fig. 2), covered with some 400 white and brown insulators of all shapes and sizes. The same firm also show iron telegraph poles for use abroad, Jobson's patent driving poles for the rapid erection of telegraph lines, and a large variety of brackets, clips, and insulators for special purposes.

THE NATIONAL TELEPHONE COMPANY.—This company have an interesting and tastefully-arranged display. Their space has been divided into three compartments, the front one being devoted to the display of various forms of telephonic apparatus at present in use, whilst the two back ones are set apart to illustrate a telephonic exchange in operation, and for the purpose of enabling visitors to test the long trunk lines now existing from Birmingham to various towns to the north and south.

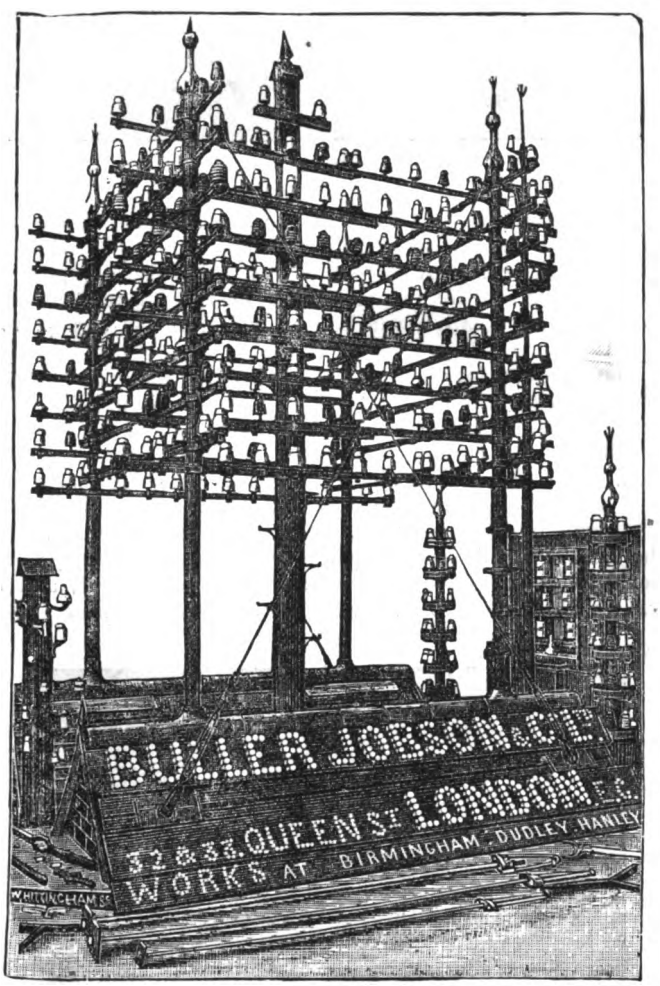

FIG. 2.—Messrs. Buller, Jobson and Co.'s Exhibit.

Taking the exhibit in detail, we noticed at the front one of the usual iron standards, from which run the various lines connecting several stall-holders within the Exhibition, together with trunk and junction lines to the main system. The leading-in wires are led on to a test-board carrying the lightning arrestors. The connecting wires run thence into the telephone exchange before referred to. Here there is a switch-board with a capacity for 80 local lines and for 12 trunk lines (metallic circuits). The switch-board has been specially designed by Mr. Alfred Coleman (general manager), and includes several patents of Messrs. Coleman and Jackson, of which special mention may be made of the trunk line translator, which has an iron shield to prevent induction from adjacent translators or coils, and by an ingenious device is made to act as annunciator, thereby saving four indicators, *i.e.*, one on local wire and one on loop line at each end. An increased efficiency is of course obtained from such a sweeping away of the resistance of otherwise necessary indicators. The adjoining compartment has the appearance of a small drawing-room, and arranged to each settee or chair are pairs of telephones, by means of which any one can hold conversation from various towns. A table set of telephones which can be handed round enables anyone to enter into the conversation. At the front of the stall, where the miscellaneous collection is grouped, we noticed among the samples of apparatus shown portable telephones, an automatic exchange (Mr. Sinclair's patent), several different forms of Messrs. Coleman and Jackson's translators and switching jacks, Messrs. Coleman and Brown's indicators, and numerous forms of call boxes for the use of the public and subscribers, including a recent one designed by Mr. Arthur E. Cotterell, the district manager, which is constructed so as to be contained within one of the usual magneto instruments in the position usually occupied by the battery, for which space is also provided. At the top of the desks are arranged two slits, one marked "pence" and the other "sixpence." On dropping the coin specified through the slit provided, it is carried down a funnel and strikes a special-toned bell, and as the apparatus is attached acoustically with the transmitter through the backboard, the sound emitted by the bell can be easily heard and distinguished by the operator at the exchange. By an ingenious arrangement, if coins of less value are dropped in no signal is given. For the convenience of subscribers special slots are fixed in the front of the box. On a subscriber inserting a special token he is enabled to send a signal to the operator at the exchange, which is clearly recognisable. These slots are two in number, one being for local subscribers and one for trunk.

Great interest was taken in this stall on the opening day by Lord and Lady Randolph Churchill, who entered into a lengthy conversation with Bradford, 123 miles distant.

THERMO-ELECTRIC INVESTIGATIONS.*

BY PROF. H. STROUD.

According to the law of Magnus (1851) no thermo-electromotive force can exist in a circuit consisting of one metal, homogeneous in structure, provided there is no discontinuity of form nor abrupt variation of temperature.

Le Roux (1867) performed a number of experiments, showing that a thermo-electric current is produced in a single metal whenever there is dissymmetry with respect to the point of heating.

Ritter in 1801, and others since, have obtained currents by bringing hot and cold wires in contact, and Franz and Gaugain have pointed out that the effect depends on the state as to oxidation of the surfaces of the metal experimented upon. Some experiments were made by Durham (1871) on the momentary current developed when two platinum wires were brought into contact, the wires being at different temperatures, and he found that the momentary current was proportional to the difference of temperature.

No experiments appear to have been made on the E.M.F. produced when two portions of the same metal are in contact, and the one portion is kept at a high temperature and the other kept at a low temperature. The results of such experiments can be predicted from the thermo-electric diagram, and, conversely, a simple and direct method may thus be obtained for the determination of the Thomson effect. It was with the view of developing this method, which was suggested by the thermo-electric diagram, that the experiments described in this Paper were undertaken.

From the thermo-electric diagram, which represents very clearly the researches, theoretical and experimental, of Sir W. Thomson and of Prof. Tait, we should expect the E.M.F. produced at the point of contact of hot and cold portions of the same metal to be in one direction for those metals for which the Thomson effect is positive, and to be in the opposite direction for those metals for which the Thomson effect is negative;

* A Paper "On the E.M.F. Produced by an Abrupt Variation of Temperature at the Point of Contact of Two Portions of the same Metal," read before the British Association, in Section A, at Newcastle-on-Tyne, September, 1889.

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copper is a good example of the former, and iron of the latter. In the case of lead, for which Le Roux found that the Thomson effect is inappreciable, we should expect no E M.F. Moreover the E.M.F. should be greater, under similar circumstances, the greater the magnitude of the Thomson effect.

In Fig. 1 we have represented the iron and copper lines of the thermo-electric diagram, with lead as the metal of reference. If copper, kept at a high temperature, indicated by position A in the diagram, is placed in contact with an identical copper conductor, kept at a low temperature, indicated by, say, position B; we should, it seems to me, expect an E.M.F. to be established from hot to cold, seeing that the Thomson effect in copper is positive; or, in other words, since an electric current flowing through a copper conductor, in which there is a gradual fall of temperature, in the direction of the current, has the effect of reducing the differences of temperature, we should expect the contact of hot and cold copper to give rise to an E.M.F. which would be in such a direction as to tend to reduce the difference of temperature, *i.e.*, from hot to cold. Similarly, if two identical iron conductors are placed in contact, the one being kept hot and the other cold, we should expect analogous results; but the direction of the E.M.F. would be opposite as the Thomson effect is negative.

Fig. 1.

The greater the slope of the line representing the metal in the thermo-electric diagram the greater we should expect the E.M.F. to be for a given difference of temperature, for the difference between the thermo-electric powers corresponding to the two temperatures is proportional to the tangent of angle of slope. To find the relation between the E.M.F. and the difference of temperature constitutes part of this investigation: the E.M.F. will be proportional to the difference of temperature in case it is proportional to the difference of the thermo-electric powers corresponding to the two temperatures; for this difference, from the diagram, is represented by difference of temperature × tangent of slope.

Hitherto the experiments made have been chiefly with copper and iron, two typical metals.

From preliminary experiments it was found necessary that the physical condition of the metal experimented upon must be identical throughout the portion of the circuit in which the abrupt difference of temperature was produced, otherwise the thermo-electric E.M.F., due to heterogeneity, quite masked that due to the cause in hand. This condition was satisfied by dividing a tube of the experimental metal, cleaning the surfaces with sand paper, and pressing the similar portions together, a mark on each portion of the tube enabling this to be done very exactly. The surfaces were carefully rubbed down so that good contact was obtained between them when pressed together. The preliminary experiments also showed clearly the necessity of keeping the surfaces in contact free from oxide; the surfaces were therefore cleaned before each experiment.

In the adjoining figure (Fig. 2) is represented the arrangement that has been found suitable. Between the two tubes *a* and *d* were placed the two tubes *b* and *c*, which were pressed together and kept in contact with each other and with the tubes *a* and *d* by means of a spring. *a*, *b*, *c*, *d* were all cut from the same length of tubing, and the ends of *b* and *c* in contact were adjacent portions before cutting. To the ends of the tubes *a* and *d* were soldered the copper or iron wires, which were connected to the galvanometer (a low-resistance Thomson), and in the circuit was included a wire which had a resistance of 0·554 ohms. At the ends of this wire was established, by means of a Leclanché cell and an adjustable high resistance, an E.M.F. of such a magnitude as to balance the thermo-electric E.M.F. The contacts of the tubes *a* and *d* with *b* and *c*, and with the soldered wires were kept at the same temperature by means of a constant current of water flowing through the tubes *a* and *d*, which were connected by an india-rubber tube not shown in the figure.

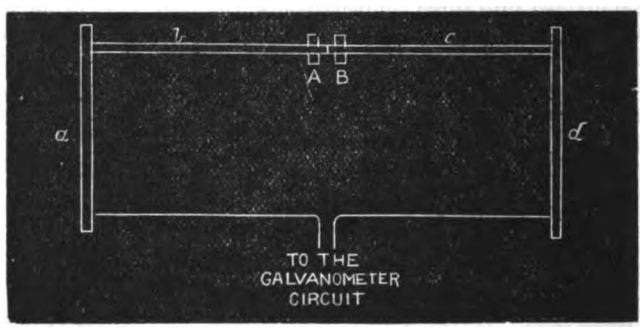

Fig. 2

A and B are two jackets round the adjacent ends of the two tubes *b* and *c*, by means of which the one end can be kept hot and the other cold. A current of steam was used to produce the high temperature and cold water for the low temperature. A and B were usually about half an inch from the ends of the tubes.

The temperatures of the surfaces in contact were approximately determined by means of two iron German-silver junctions, which were placed in small holes drilled as near as possible to the surfaces in contact, the hot junction being bare, while the cold was prevented from touching the metal (and so short-circuiting the E.M.F. to be measured) by means of a small india-rubber tube. It was previously verified that the E.M.F. in this subsidiary temperature circuit was proportional to the difference of temperature of the junctions, and it was found that it = 23 microvolts per degree difference.

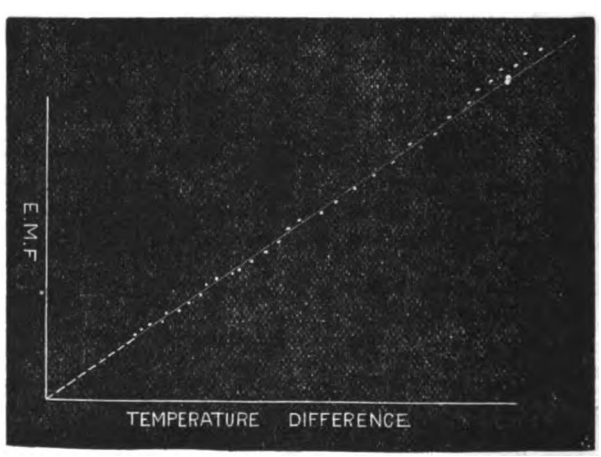

Fig 3

Experimenting with $\frac{3}{8}$″ copper tubes an E.M.F. was established from hot and cold across the junction, showing that the Thomson effect is positive. The magnitude of the E.M.F. was for one experiment, for which the abrupt difference of temperature at the surface in contact was approximately estimated at 30° C., 6·0 microvolts when A was hot and B cold, 5·4 microvolts when A was cold and B hot.

It should be stated that before dividing the tube, of which *b* and *c* formed parts, a similar experiment was made, but no E.M.F. obtained, showing that it is to the discontinuity in the temperature gradient rather than to the steepness of the gradient that the E.M.F. is due.

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Similar results have been obtained with $\frac{3}{8}$" iron tubes, no E.M.F. being obtainable when the tube is entire, but on division an E.M.F. from cold to hot across the junction, *i.e.*, in the opposite direction to that obtained with the copper tubes, and of far greater magnitude. With a difference of temperature approximately estimated at 30°C the E.M.F. obtained was 74·6 microvolts.

A preliminary experiment has been made, in the case of iron, on the relation between the E.M.F. and the difference of temperature within the range of the above experiments. The method employed was as follows:—When the whole had attained its temperature equilibrium, the steam was stopped while the current of cold water was continued as before; then, while the hot portion was cooling, readings of the two galvanometers were taken alternately, the one galvanometer in the thermo-electric iron German-silver circuit indicating the temperature difference, and the other in the main circuit indicating the E.M.F. From these alternate readings, taken at equal intervals of time, simultaneous readings were deduced by interpolation.

On plotting the curve (Fig. 3) giving the relation between the E.M.F. and the temperature difference it is found to be a straight line, showing that the E.M.F., in the case of iron and within the range of the experiments, is very nearly proportional to the difference of temperature, as indicated by the junctions placed in the manner described.

The following are the numbers from which Fig. 3 was drawn:—

E.M.F.	Temperature Difference.	Ratio.	E.M.F.	Temperature Difference.	Ratio.
304·5	382	·797	114	144	·792
287	352	·816	107·5	137	·785
272	330	·824	101	129	·783
256·5	310	·808	95·5	124	·772
233·5	286	·816	90·5	117	·773
213	267	·798	85·5	110	·777
201	252	·798	81	104	·779
188·5	236	·799	77	99	·778
176·5	222	·795	73	94	·777
165·5	207	·800	69·5	89	·781
155	196	·791	66	84	·786
145	182	·797	62·5	81	·790
136	173	·786	60	77	·779
128	162	·790	57·5	74	·777
120·5	154	·783	54·5	71	·768

The results, so far, of these experiments are:—

(1) The direction of the E.M.F. is opposite in the case of the two typical metals, iron and copper, being from hot to cold across the junction in the case of copper, and in the reverse direction in the case of iron.

(2) The magnitude of the E.M.F. is very much greater for iron than for copper, which corresponds to the much greater slope of the iron line in the thermo-electric diagram.

(3) The magnitude of the E.M.F. is, for the case of iron and within the range of the experiments, proportional to the abrupt difference of temperature on either side of the point of contact.

THE CHENOWETH ELECTRIC CONDUIT.

The following is the report of the Sub-Committee of the Committee on Science and the Arts, constituted by the Franklin Institute of Pennsylvania, to whom the Chenoweth electric conduit was referred for examination. The Sub-Committee consisted of Messrs. Carl Hering, Richard W. Gilpin, Charles H. Richardson and G. Betton Massey:—

"The invention belongs to that class of conduits in which the material of the conduit is packed, while in a plastic condition, around one or more cylindrical cores, which are removed after the plastic material has hardened. The essential part of the invention is the nature of this removable core, which enables it to be withdrawn in long lengths. This core consists of a ribbon of galvanised iron, 1in. wide and of a thickness equal to No. 27 gauge, which is wound spirally, forming a tube. This spiral tube is rendered rigid, either by being wound around a split wooden core or by having paper glued around the outside. The plastic material is packed around these tubes, and after it has set the tube is removed by pulling out this spiral band. When paper has been used to hold the spiral together it readily tears, allowing the band to be removed. When wooden cores have been used, they are first withdrawn, after which the spiral band is readily pulled out.

Among the details of the system are the following:—

When paper is used to unite the spiral into a rigid tube, the ribbon is first wound spirally on a mandrel, then covered with paper, which is glued fast to the outside of this spiral, and the whole covered with a waterproof varnish. The mandrel is then removed, leaving a thin tube, which appears to be quite rigid, and capable of withstanding the pressure due to the packing of the plastic cement of the conduit around it. These are laid in lengths and held in position while the cement for the conduit is packed around them. The ends of the one spiral ribbon are fastened to the beginning of the next by a swivel joint. After a few days, when the cement has hardened, the spiral ribbon is pulled out at one of the manholes, tearing and thus removing the paper around it. It is claimed that long lengths of this spiral tube can be thus removed.

When this spiral tube is wound over a wooden core, this core is made in two semi-cylindrical halves, separated by a thin iron strip. The outside is painted with a mixture of clay, powdered soapstone, and water. These are laid in lengths of 14ft. to 20ft., and after the cement is packed around them the wooden cores are withdrawn, after pulling out the strip of iron separating them. This leaves the spiral tube, which remains until the cement has hardened and is then withdrawn in long lengths.

The inventor claims that continuous lengths of 400ft. of spiral tube can thus be withdrawn. For removing this ribbon, the inventor states that he has a peculiarly constructed reel, by means of which the ribbon can be pulled out, wound up and untwisted in one operation.

For the material used for the conduits, the inventor prefers a mixture of one part of hydraulic cement and two parts of sand. The costs are given by the inventor as follows:—

'The cost of constructing ducts by this method is narrowed down to the winding of the ribbon on the mandrel, the labour of removing the mandrels in the trench, of removing the ribbon from the duct and rewinding the ribbon on the bobbins. And as each part of the core is preserved and used an indefinite number of times, the cost of the core is charged to the cost of the plant. The winding of the ribbon is done on the spot as fast as wanted. The cost of drawing out the ribbon and rewinding on bobbins, using an ingenious device that removes all twists, is about one mill per foot. A duct, 4in. in diameter, made of concrete, in the proportion of one of cement to two of sand, can be made for six cents per foot, including entire cost, exclusive of excavation, manholes and openings.'

The inventor claims that the advantages of the paper-covered tube is convenience, the cost being about the same.

The inventor gives the following comparative costs of materials for three forms of conduits. The estimate is for a conduit of four ducts, 4in. in diameter, 1ft. long. For creosoted wood, six cents per foot per duct; for iron pipe encased in concrete, 18 cents per foot per duct; for his conduit, three cents per foot per duct. This does not include excavation, which is about the same for all. It does not include the cost of handling his removable core.

Your committee have examined samples of these removable cores, and portions of conduits made in this way, and are of the opinion that the invention is simple, ingenious, effective and inexpensive. Furthermore, an invention of an efficient removable core enables monolithic conduits to be made of hydraulic cement, whose properties are already well known. Unlike creosoted wood, it contains no substances which are likely to attack chemically the insulation or the lead armour of cables, and unlike iron it does not corrode. The results, therefore, which can be accomplished by means of this removable core are unquestionably of value.

Your committee recommend the award of the John Scott Legacy Premium and Medal to Alexander Crawford Chenoweth, for his improved method of laying continuous electrical conduits."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, September 27th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the St. James's Hall Restaurant.

TUESDAY, October 1st.

ROYAL VICTORIA HALL.

8:30 p.m. "Underground Mountains." By Prof. A. W. RÜCKER.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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MR. SWINBURNE ON THE DESIGN OF TRANSFORMERS.

It is probably within the mark to say that 90 per cent. of the alternate-current transformers now in use owe their evolution to a process chiefly empirical; one in which calculation has only been employed to modify, and has done but little to forecast experimental results. It has been generally believed, moreover, that high efficiency could be quite easily attained (at least under full load) by any inter-linked combination of copper and iron, and in this belief makers have, as a rule, been content to rest. Mr. SWINBURNE will have done good service if his Paper serves only to call attention to the atrociously bad performance of which some of the transformers exemplified in his Tables are capable. Mr. SWINBURNE is not the first writer, as he also modestly indicates in his opening paragraph, who has furnished formulæ for the design of transformers on scientific lines, but his discussion of the problem is more detailed and in many respects more complete than any of his predecessors. His theoretical investigation results in an equation (unfortunately a cubic) whose solution is intended to yield the most economical value (under actual working conditions) for the dimensions of the core. The following are the quantities in terms of which this value is to be expressed:—The induction in the iron, the frequency, and the resulting loss by hysteresis per cubic centimetre of iron, the current density in the coils, the loss per cubic centimetre in the copper, and the *total* output. It will be at once observed that nothing is set down for the Foucault current losses, and near the close of the Paper the author justifies their neglect in the following sentence (the italics are our own):—

"The loss by Foucault currents has not been taken into account in this Paper, as it can be reduced to any desired extent by laminating or using fine wire; *but the plates must be very thin to make it really negligible.*"

There is, however, some evidence to show that this omission is much more serious than the Author seems to suppose. In a set of experiments in which the conditions were comparable to many of the cases entered in Mr. SWINBURNE's tables (the magnetisation being 12,300 and the frequency 30), it was found by Mr. MORDEY (*Jour. Inst.*, No. 81, p. 621) that with iron plates ·048 centimetre (·012in.) thick the loss in Foucault currents was roughly *three times as great as that due to hysteresis.* These experiments will be found to be in fair agreement with those of EWING and HOPKINSON, from which the eddy currents can be obtained by difference. Mr. SWINBURNE, on the other hand—

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basing his conclusions upon a formula originally given, we think, by Lord RAYLEIGH—arrives at results which make the eddy current losses less than 10 per cent. of these values. This is very unsatisfactory, and it would seem desirable that the whole question of eddy currents should be more completely thrashed out than has yet been done. It is, however, due to Mr. SWINBURNE to remark that if he had taken the eddy current losses into consideration in his formulæ his general argument would, so far as appears upon the surface, have been considerably strengthened.

From the point of view of the practical designer we have, however, to consider what thickness of iron shall actually be employed, and we do not get much help by being told that the eddy current losses "can be reduced to any extent by laminating the iron," because this is, in fact, an expensive process, and if we are to learn how to make the most economical transformer for given conditions of working, it is certainly of importance to know whether we can use iron costing 3d. per pound (as the author takes it all through), or whether we must pay perhaps twice as much for it.

Passing this by, we note as a singular fact that Mr. SWINBURNE has calculated his tables (with one or two exceptions) upon the basis of a constant current density for all outputs. In the first table the output of different sizes ranges from 2 to 1,000 lamps, but the current density is maintained at 1,000 amperes per square inch throughout. This may be an oversight; or it may possibly be connected with the remark made in an earlier paragraph, that "a dynamo which gets hot is not necessarily inefficient." This is quite true up to a point, but the argument is one which must be handled with due caution. Mr. SWINBURNE proceeds to say a little vaguely that "a large transformer can radiate more heat than a small one, and can thus keep cool, though less efficient." The proposition is perhaps better stated somewhat in the following way:—If two similar transformers (or other machines) of different sizes dissipate energy at the same rate, the larger, having the greater actual surface, will assume a lower temperature, whilst if the rate of dissipation of energy is proportional to the mass, the smaller machine will be the cooler. We need not, however, further consider the actual figures contained in the tables, because, as may be seen in Table IX., and as the author himself admits, the regulation of the secondary E.M.F.—a point, it need hardly be said, of vital importance—is in most cases hopelessly bad. We fear, therefore, that Mr. SWINBURNE's formula will meet with little appreciation amongst practical men unless he can modify it by the introduction of a term to determine the maximum percentage fall of potential in the secondary coil.

In the second part of his Paper the author gives us a series of scale diagrams, showing the proportions of iron and copper in transformers designed on the same basis, but under various conditions as to induction and "time load" (*i.e.*, number of hours per day when full load is on). The frequency is now raised from 33 (the figure at which it stands in the first eight tables) to 80. Foucault-current losses are still disregarded, although it must be remembered that whilst hysteresis increases (at least approximately) as the frequency, the eddy currents increase *as the square* of the frequency. The conclusion arrived at is that—

"The best full lead transformer is bad for short loads, but a short load transformer, though more efficient at short loads, and not much inferior under continuous full load, is a hopelessly bad regulator, besides being too expensive in copper."

A mere inspection of the diagrams is quite sufficient to lead one to the same conclusion (at least as regards the latter part), the copper bearing an extravagantly large ratio to the iron.

Finally, the author propounds a remedy of a somewhat heroic type. This is nothing less than a return to the open magnetic-circuit transformer. The first effect of this modification is obviously to reduce the quantity of iron in which losses by hysteresis (and eddy currents) can take place; but in order to keep down the primary current at no load and to maintain the induction the copper must be still further increased. Unfortunately, at least for purposes of discussion, the mathematical expressions prove unmanageable, and Mr. SWINBURNE recommends the process of working backwards from assumed proportions. The subject is only developed to a very meagre extent, but he tabulates some results (*not* experimental) in which the efficiencies both for full and short loads came out better than with the closed circuit transformer already calculated for the same induction and frequency. In one case the fall of potential is 2·46 per cent., which is a little worse than in the corresponding closed circuit-transformer; and in the second case it stands at 4·35 per cent., which, though bad in itself, is better than the corresponding one.

It is evidently impossible upon the evidence before us to decide whether in general by this method of construction the saving of energy in the iron is or is not an equivalent for the increased loss of energy in the copper *when proper regulation has been provided for.* So far as we can see at present this question of regulation must at the best very much limit the successful application of Mr. SWINBURNE's ingenious proposals. The question also arises whether, after all, there does not exist some quite different and perhaps more entirely satisfactory method of treating the problem of transformer efficiencies under varying loads. We venture to prophesy that some such method will ultimately be found. But meanwhile we must all feel grateful to Mr. SWINBURNE for the immense amount of trouble he has taken in preparing so elaborate a Paper, dealing as it does with a subject of peculiar difficulty and of much practical importance.

THE DESIGN OF TRANSFORMERS.*

BY JAS. SWINBURNE.

(*Concluded from page 495.*)

Leaving these tables, as the induction might be considered too high, and as the loss might also be considered excessive, we may return to our equation:—

$$3\,l\,x^6 + 2\,l\,b\,x^4 - 2\,k\,p\,d^2\,b^2\,x^3 = 6\,k\,p\,d^2\,b^3.$$

The more usual frequency of 80 per second will be taken. The current density d will be taken at 150 amperes per square centimetre, which is about 1,000 per square inch. The primary will be taken at 2,000 volts and 1·5 amperes, and the secondary at 100 and 30. Allowing for double cotton insulation, and assuming the sectional area occupied by a wire to be the square of its over-all diameter, $k = \cdot375$.

To find l, the waste of power per cubic centimetre of iron for any virtual induction, such as 10,000, we may take the loss per cubic centimetre from Prof. Ewing, and multiply by the frequency; this allows a margin for the air spaces among the wires or plates, and comes about right with round wire. It is not likely that the iron used in commercial transformers is nearly so well annealed as Prof. Ewing's specimen, and it is generally handled a good deal in the workshops. A small allowance should also be made for Foucault currents. Some authorities would also make an addition for viscous hysteresis.

The specific resistance of copper is about 1·8 microhms. All the coefficients in the equation can now be replaced by numbers.

In the tables already given the induction was always 14,000;

* Paper read before the British Association in Section G, Newcastle-on Tyne, September, 1889.

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we will now work out some examples with low and high inductions for various time loads, but always, for ease of comparison, for 50 lamps, or 3,000 watts.

No. 1 (Fig. 2), with virtual induction of 7,000 designed for full load always on, has an efficiency of 95·2, and a drop of E.M.F. of 2·3. The same transformer run at full load for two hours a day, or at half load for eight hours a day, has an efficiency of 74·7. The figure is to scale.

No. 2 (Fig. 3), with same induction, designed for two hours a day, has 81·5 efficiency, and at full load always its efficiency goes up to 92. Its drop is no less than 7·3.

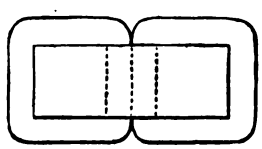
No. 3 (Fig. 4), with virtual induction of 10,600, designed for continuous load, has 95·1 efficiency, and at two hours a day, 72·5; drop 2·2.

No. 4 (Fig. 5), same induction, designed for two hours a day, has 81 efficiency, and 91·5 under continuous load, the drop being 8. No. 5, with induction of 14,000, has efficiencies of 94·6 and 71·2, and drop of 2·3.

No. 5 (Fig. 6), with induction of 14,000, has efficiencies of 94·6 and 71·2, and drop of 2·3.

No. 6 (Fig. 7), with same induction, designed for two hours a day, has 77·5, and 90 per cent. on continuous full load, drop being 9·2.

Fig. 2



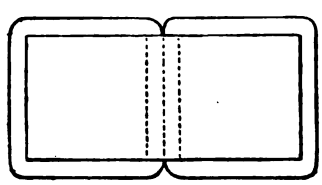
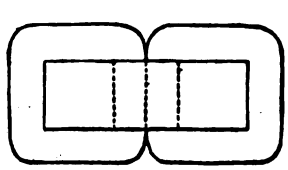


Fig. 3

These examples show that a low induction is a little better, but it can hardly pay for the extra cost. The chief point is that the best full load transformer is bad for short loads, but a short load transformer, though more efficient at short loads, and not much inferior under continuous full load, is a hopelessly bad regulator, besides being too expensive in copper.

Fig. 4.



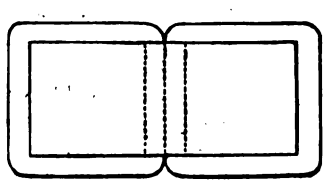


Fig. 5.

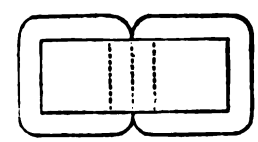
Suppose, instead of a closed iron circuit we use a transformer of the Ruhmkorff coil type. The iron will be less, but the magnetising current will be considerable, especially in small sizes. To reduce this difficulty, I carry the ends of the wire cores out past the cheeks of the coils, and then spread the wires out into a sort of thistle-head or hedgehog. The magnetising current cannot even then be left out of account, as it may be very considerable. The magnetising ampere-turns depend on the dimensions of the transformer, and the size and current density of the primary depend partly on the magnetising current, and these quantities are involved in such a way that a calculation to find the best form for a given case gives three complex and unmanageable simultaneous equations. It is much quicker to find the best form by trial, altering one dimension at a time, as independent variable, till a good result is obtained.

To get the magnetising current, or the primary current at no load, the bushy end is taken as having a hemispherical surface, and the direction of the induction in the air is taken as radial, whereas it really curves round on all sides to the other hemispherical surface. The magnetising current is thus very slightly over-estimated. The primary current is taken as the root of the sum of the squares of the magnetising and the main current. Calling the diameter of the core w, the length of the coil and straight part of the core t, the thickness of winding z, and the radius of the hemisphere y, the magnetising ampere turns per centimetre of iron h, the total excitation needed is

$$h\,(t+2\,y)+\int_{y}\frac{B_{y}\,w^{2}\cdot 64\,dy}{16\,\pi\,y^{2}}.$$

The first term may be neglected.

Fig. 6.



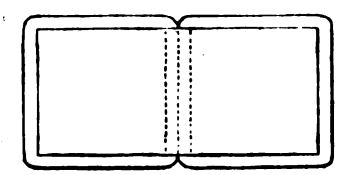
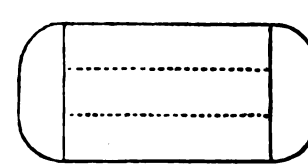


Fig. 7.

As example, No. 7 (Fig. 8), we may take a medium induction of 10,600, and take w as 5·5, t as 25, and y as 8. At full load, for which this is designed, the efficiency is 96·2; at two hours it is 77·3, and the drop is 2·46. In estimating the efficiency at two hours a day, allowance is made for the loss in the primary when the secondary is open. This is small in power, but it is of considerable importance, as it is always on.

Fig. 8.



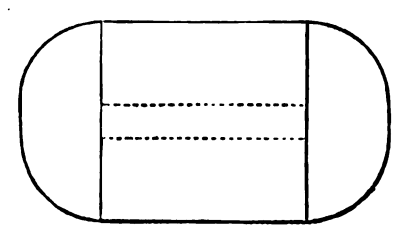


Fig. 9.

No. 8 (Fig. 9) is for short loads. The core is 4 centimetres in diameter, and the ends 10 centimetres radius. Its two hours' efficiencyis 86·6, and at continuous full load it is 95. The primary current density is here taken less to keep down the loss due to the no load magnetising current.

Table XI. shows these results for easy comparison. It will be seen that the last example has at full load almost as high an efficiency as 1 or 3, which were specially designed for full loads. At two hours it is very much superior; but its drop is rather

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serious, and it takes a lot of copper. No. 7, on the other hand, though designed for constant full load, has nearly as high a light load efficiency as the closed circuit light load transformers, and has a small drop, and has least material of any.

TABLE XI.

No.	B_v	Power.		Efficiency.		Drop.
		Iron.	Copper.	24 hours.	2 hours.	
1	7,000	80	65·5	95·2	...	2·3
„	„	960	„	...	74·7	„
2	„	453	220	...	81·5	7·3
„	„	38	„	92	...	„
3	10,600	88	66·5	95·1	...	2·2
„	„	1056	„	...	72·5	„
4	„	477	240	...	81	8
„	„	40	„	91·5	...	„
5	14,000	101	69	94·6	...	2·3
„	„	1212	„	...	71·2	„
6	„	590	275	...	77·5	9·2
„	„	49	„	90	...	„
7	10,600	44·5	74	96·2	...	2·46
„	„	534	349	...	77·3	„
8	„	276	197·5	...	86·5	4·35
„	„	23	130·5	95	...	„

The diagrams show that the closed circuit transformers designed for light loads are absurdities that no one would think of making. It must also be remembered in connection with them that the assumption that the only E.M.F. induced in the coils is due to the core induction is obviously absurd.

Where the copper coils are relatively small, it may be assumed that the electromotive force in each depends only on the iron; but in all the cases given allowance must, in practice, be made for lines of induction which do not pass through the iron, produced by each coil. Obviously it would be best to mix the primary and secondary wires together; but there are great practical objections to this, as the wires are then difficult to insulate properly, and the capacity of the transformer as a condenser may be great enough to involve danger to life.

Probably transformers for very short loads could be made very much better than Nos. 2, 4 or 6, without any iron. In 1882-3, seeing in an electrical text-book that an iron core merely concentrated the lines of induction, without increasing their number, and knowing no better myself, I argued that as there was loss of power in magnetising the iron, a transformer with the wires mixed would do without iron. I made one with a commutator driven by a motor for direct currents. It lighted part of a Swan carbon, but gave a very small output, and the commutator sparked. I also tried an alternating current; but, as a matter of fact, the transformer was very badly designed. Messrs. Gaulard and Gibbs were really first with mixed wires, which is not a point of no importance, even with cored transformers. I took out a patent in 1884, when the fees were reduced, but it is not even worth the reduced cost. It is merely a matter of theoretical interest that with mixed wires, and a lavish expenditure on copper, an efficient short-load transformer might be made. In the transformers we have discussed the coils must be separated, and the primary has to be given fewer turns, and the secondary more, to give the right output.

The loss by Foucault currents has not been taken into account in this Paper, as it can be reduced to any desired extent by laminating or using fine wire; but the plates must be very thin to make it really negligeable.

Take a piece of wire 1 centimetre long, of radius r. The virtual E.M.F. on any elementary layer is $4 B_v r^2 \pi n$, and the resistance of such a layer is $\frac{2\pi r R}{dr}$, where R is the specific resistance of warm iron, say 10 microhms. This gives the power $\frac{2 B_v^2 10^{-16} n^2 \pi r^4}{R}$ in the little piece of wire. There are $\frac{1}{4r^2}$ pieces per cubic centimetre, so the watts per cubic centimetre $= \frac{B_v^2 10^{-16} n^2 \pi r^2}{2R}$. To reduce the Foucault current heating to one-fifth of the hysteresis heating at an induction of 10,000 with 80 periods per second needs wire ·06 centimetre in diameter, which is between Nos. 24 and 23 B.W.G.

The Foucault heating in punchings of sheet iron cannot generally be calculated, but is near enough for our purpose if we take circular punchings like dynamo discs of about the same size. For instance, instead of punchings to suit No. 1, we can take washers of 10 and 20 centimetres internal and external diameters. The power lost in a disc by Foucault currents is $P = \iint \frac{8 B_v^2 10^{-16} n^2 t^2 \pi r \, dt \, dr}{R}$, or $\frac{8}{3R} B^2 10^{-16} n^2 t^2$ per cubic centimetre. To give a Foucault current loss equal to one-fifth of the hysteresis loss, with an induction of 10,000 and a frequency of 80, needs sheet iron ·0225 centimetres, or just over No. 35 B.W.G. Of course there are similar losses in iron-cored dynamos. For the thicknesses of iron in common use, the tables I. to X. are probably not far wrong.

In conclusion, it would seem that, from the point of view of the coal bill at the central station, the system of putting transformers permanently on in houses is hopelessly bad. But the coal bill is not everything. The cost of electrical energy does not vary as the coal burned. The house transformer system has also the disadvantage of variations of secondary E.M.F.

Assuming the private transformer system to be necessary, the open circuit transformer, of the kind I have now the honour of explaining, is better for such sizes as 50 lights. If larger sizes are needed the hedgehog kind easily distances the closed circuit; for its drawback is its large magnetising current, and the excitation is less in proportion as the transformer is increased. In all cases a large transformer is more efficient than a small one; its percentage loss decreases faster than the dimensions increase, but the dimensions increase very slowly with the output, so that it takes a very large transformer indeed to get an efficiency of 98 per cent., namely, about 50,000 watts.

If the figures for loss in iron here taken are very low, as seems probable, the arguments in favour of this form of open circuit transformer are very much strengthened. The loss in iron also depends on the frequency, so the higher the frequency the better these transformers are in comparison. It is curious to note that this appears to be a step backwards according to most people's ideas, and that it is also a step towards the original practice of the pioneers of transformer work—Messrs. Gaulard and Gibbs.

DISCUSSION.

Prof. GEORGE FORBES said there were some few points in Mr. Swinburne's Paper to which he would like to draw attention. He was glad Mr. Swinburne had drawn attention to the fact that such very bad transformers were being made by some people at the present time, and also to the fact that since many of the modern transformers have very large loss from hysteresis, it would be much wiser, as Lord Rayleigh pointed out in the *Philosophical Magazine* a few years ago, to have open-circuit transformers to prevent hysteresis from being injurious. He thought Mr. Swinburne was mistaken as to the figures that had been given as to efficiency being so very incorrect. The transformers that Dr. Hopkinson examined of Gaulard and Gibbs, even in those old days when certainly they were not in the most efficient condition possible, were very high indeed; and those he (Prof. Forbes) had examined himself by calorimetric methods had been higher than the figures given by Mr. Swinburne.

Prof. EWING said it had occurred to him that the essence of his (Mr. Swinburne's) conception lay in this—that in the magnetic circuit of a transformer they might on the one hand have the circuiting of the system wholly of iron, a substance having exceeding permeability, but at the same time it is open to the objection that when a magetic circuit is formed there is a certain dissipation of energy through hysteresis. On the other hand they might have the magnetic circuit consisting more or less of air, a substance having little permeability, but also possessing the advantage of having a cycle where there is no dissipation from hysteresis. Mr. Swinburne's suggestion of the hedgehog appeared to him to mix those two—to have the central part iron and then air to complete the circuit. It seemed to him probable that a better result would be achieved by simply reducing the quantity of iron in an iron circuit; but one must bear in mind that the dissipation of energy through hysteresis in iron becomes very much less in proportion to the induction when the induction is higher—that is to say, the iron becomes, so to speak, more nearly elastic as regards its changes of magnetisation.

Prof. S. P. THOMPSON said he did not agree with Prof. Ewing's last remark because, unfortunately, though it might be proved that one got better elasticity with the higher magnetisation, one was also doing so much work on the iron *in toto* that the iron would get

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very hot unless it had an adequate surface, but it could not have the adequate surface with the small quantity Prof. Ewing supposed. The real point of Mr. Swinburne's Paper seemed to him (Prof. Thompson) to be that he had introduced into the magnetic circuit of a transformer a certain portion of air, and gained thereby. Perhaps it was better to explain it by analogy. At one time it was thought well to regulate alternate-current systems by the introduction of resistance; now it has been found better to regulate alternate-current systems by the introduction of reaction coils, which do not dissipate energy as plain resistance would. If they wanted to regulate the action of the transformer by acting on the iron part, or rather on the magnetic part, as distinct from the electric part of it, they could do it by increasing the magnetic resistance by thinning the iron, or they could do it, not by thinning the iron, but by cutting out a gap and leaving the air. In the one case, thinning the iron would leave them in the presence of the iron which dissipates energy; in the other case, introducing the air-gap would leave them in the presence of the air which did not waste the energy, being magnetic and perfectly elastic. The gain is similar to that of putting in a reaction coil as against a resistance coil in the electric circuit. He was not sure that he could agree with Mr. Swinburne's way of constructing this coil. What was the real gain of spreading out the heads of a core into a hedgehog, as it was called? He not only believed that the arrangement of the iron wires when spread out in that way added to the difficulty of the construction, but he was not sure that it did not add to the risks. He would much rather see a plain cylindrical coil of wire that had to be opened out in the usual way. Mr. Swinburne did not say how long his core was. Of course the question how far it induced magnetic resistance depended upon the length of the core between the two wires.

Mr. PREECE said he had very few remarks to make, except remarks of praise. He thought that was the kind of Papers they wanted. In the present day they were jumping by leaps and bounds, and improving all their systems of distribution particularly and all their systems of apparatus very often indeed; and when they found men deliberately setting to work and studying questions with the experience and the mathematical knowledge, and with the care of Mr. Swinburne—why, they could only hail such papers with pleasure. There was one point Mr. Swinburne had not touched upon. That gentleman had alluded to the fact that in transformers there was an immense amount of waste when the instruments were lying idle. There was no doubt there was an immense amount of waste. The diagrams of the working of the central system in London show that during the daytime there is an immense amount of power gone—really lost in heat. At the present moment experiments were being made, and people were trying to devise switches by which the transformers shall be switched off during the day and the users of light shall only switch the transformers on when they are wanted at night. Why it was not done he did not know—there might be some reason unknown to him—but he knew that some of the large companies were working in that direction.

Mr. SWINBURNE said Prof. Forbes had pointed out that the old Gaulard and Gibbs transformers gave very high efficiency—he had forgotten what the figure was, but he thought Dr. Hopkinson had found something like 88 per cent., and on the whole that was rather a confirmation of his Paper, because they were open-circuit transformers, and they were not the best designed, being generally rather too long. It was also mentioned, as had been mentioned before, that open circuits were more efficient. He had the idea that the ground on which they were mentioned before was that if you had the open circuit the loss per cubic centimetre of iron at a given induction was less, owing to the free magnetism at the end of the core. He did not know whether he was quite right in saying that or not. Prof. Ewing said the iron ought to be reduced to a higher induction. In the Paper he had taken several inductions. The high induction produced rather a low efficiency. He did not quite follow Prof. Ewing's figures, for the losses per cubic centimetre were taken from the one case in his classical Paper, in which what Prof. Ewing called the graded cycles were taken. Prof. Thompson said he did not quite follow the advantage of spreading out the ends, or hedgehogging. He (Mr. Swinburne) did not like to use the term "magnetic resistance," but perhaps he might be allowed to do so. Hedgehogging the ends made the magnetic resistance of the air smaller. The magnetising current was so large that at full load the loss in the primary was something enormous—that was why it had to be so large—and even at no load the loss in the primary came to something very considerable. He thanked Mr. Preece for his kindly remarks. What that gentleman had said about the great loss shown in load-diagrams at stations to a certain extent contradicted Prof. Forbes's experiments as to the high efficiency of transformers.

Prof. FORBES: I did not speak about bad transformers; it was in good transformers I found good efficiency.

Mr. SWINBURNE: I can only say, then, that most central stations must use very bad transformers, in which Prof. Forbes will, perhaps, agree with me.

ON MAGNETIC VISCOSITY IN IRON.*

BY J. A. EWING, B.SC., F.R.S.

When any change is made to take place in the magnetic force acting on a piece of soft (annealed) iron, a considerable time elapses before the resulting change in the magnetism of the piece is complete. The sluggishness which soft iron exhibits in assuming its full magnetism when a magnetic force is imposed upon it was referred to as follows in the account which I wrote, some years ago, of experiments on the magnetic qualities of iron:—†

"Some evidence was given that, in addition to much static hysteresis, there is a small amount of viscous lagging in the changes of magnetism which follow changes of magnetising force. I repeatedly observed that when the magnetising current was applied to long wires of soft iron, either gradually or with more or less suddenness, there was a distinct creeping up of the magnetometer deflection after the current had attained a steady value, as measured by the deflection of the galvanometer through which it passed. This action was sometimes so considerable as to oblige me to wait for some minutes before taking the magnetometer reading."

In his Paper "On the Behaviour of Iron and Steel under the Operation of Feeble Magnetic Forces,"‡ Lord Rayleigh has remarked on the same phenomenon in soft iron. In his experiments the relation of the magnetic force to the resulting magnetisation of the specimen was studied by means of a magnetometer furnished with a "compensating coil," through which the magnetising current passed, and which was so placed that its action on the needle of the magnetometer balanced the action of the iron, giving no deflection. When very feeble magnetic forces were applied to hard iron or to steel, he found that a perfect balance might be obtained by adjusting the position of the compensating coil, and so established the fact that the susceptibility to small magnetic forces, or to small changes of force, is a definite quantity, which is independent of the amount of the small change of force. He observes that with hard iron and steel the compensating coil might be set so that neither at the moment of closing the circuit of the magnetising current nor afterwards was there any deflection of the magnetometer, which means that (so far as the magnetometer can decide) the metal assumes its magnetic state instantaneously. He goes on to say that soft iron shows much more complicated effects:—"When the coil was so placed as to reduce as much as possible the instantaneous effect, there ensued a drift of the magnetometer needle . . . in such a direction as to indicate a continued increase of magnetisation. Precisely opposite effects followed the withdrawal of the magnetising force. The settling down of the iron into a new magnetic state is thus shown to be far from instantaneous. On account of the complication caused by the free swings of the needle, good observations on the drift could not be obtained with this apparatus, but it was evident that whilst most of the anomalous action was over in 3 or 4 seconds, the final magnetic state was not attained until after about 15 or 20 seconds." Lord Rayleigh then cites my observation, quoted above.

In the following experiments, Lord Rayleigh's method of the compensating coil has been made use of for the purpose of examining in some detail this "drift," or "creeping," or quasi-viscous change of magnetism which follows any change in the magnetic force acting on soft iron.

The magnetometer was a light Thomson mirror directed by the horizontal component of the earth's field, and having a free period of double swing amounting to nearly 1½ seconds. The specimen of iron used in the greater number of the experiments was a straight piece of thick wire 0·404 centimetre in diameter and 39·6 centimetres long, over which was slipped a tube with a magnetising solenoid wound upon it. The wire was set in a verticle position, magnetically west of the magnetometer, with its top end on a level with the mirror, and generally 6 centi-

* Read before the Royal Society, June 20. Read in abstract before Section A, British Association.

† "Exp. Researches in Magnetism," *Phil. Trans.*, 1885, p. 569, § 52.

‡ *Phil. Mag.*, March, 1887, p. 230.

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metres distant from it. The compensating coil was wound on a wooden frame, which could be moved along a "geometric slide" towards or from the magnetometer in the east-west line through the mirror, for the purpose of balancing the magnetic effect of the iron. In some of the experiments another compensating coil was used to balance the effect on the magnetometer of the magnetising solenoid, but generally the simpler plan was followed of including the effect of the solenoid in the determination of the compensating coil's action on the magnetometer.

To prevent the vertical component of the earth's field from acting on the iron, a second magnetising solenoid was wound over the first, and a constant current of the proper strength to neutralise the earth's field was maintained in it without interruption. The main magnetising current was regulated by having in its circuit a box of resistance coils, and also the liquid slide described in my former Paper.* This allowed the magnetic force to be changed either suddenly or gradually, and the slide also allowed the method of demagnetising by numerous reversals of a continuously diminishing magnetic force to be resorted to whenever it was desired to reduce the iron to a magnetically neutral state.

To soften the wire it was heated to redness by being slowly drawn through a Bunsen flame. After it was put in place the method of reversals was applied to extract a small amount of magnetism which it had acquired in being handled. In the experiments which I shall first describe the effects of very feeble magnetic force were examined by making and breaking the circuit of the magnetising solenoid while the current was adjusted to produce a force of less than 0·1 C.-G.-S. It was found that the *immediate* effect of each make and break could be balanced very exactly by adjusting the position of the compensating coil, and so long as the magnetising force was considerably less than 0·1 C.-G.-S. the distance at which the coil had to be set to give this balance was as nearly as possible independent of the value of the force, and was the same for "break" as for "make." The position of the coil was adjusted so that at the instant when the magnetising current was set up by pressing down a contact key, there was no sudden deflection of the magnetometer mirror to either side. When the compensation was right the spot of light simply began to drift slowly towards the side corresponding to increase of magnetism; when there was over-compensation, the spot of light gave a quiver to the opposite side before beginning to drift, and the position of the coil was adjusted by drawing it back little by little until the quiver on pressing down the key disappeared. The amount of magnetism that was balanced was afterwards measured by removing the iron, but leaving the magnetising solenoid and the compensating coil in place, and observing the deflection of the magnetometer when the same current was passed through the empty solenoid and the compensating coil. This determined the immediate magnetic effect of the magnetising current on the iron, and the subsequent creeping up of the magnetism was of course determined by observing the drifting of the magnetometer needle which had ensued after applying the current while the iron was in its place.

In the following experiment a current of 21 on the arbitrary galvanometer scale (equivalent in this case to a magnetising force of 0·044 C.-G.-S.) was made, after the wire had been completely demagnetised, and after the compensating coil had been adjusted to balance the immediate effect. Magnetometer readings were taken 5 seconds and 60 seconds after "make;" and at 60 seconds the current was broken, and magnetometer readings were taken 5 seconds and 60 seconds after "break." The immediate effect (balanced by the compensating coil) was equivalent to twenty-five divisions of the magnetometer scale :—

Time after "make."	Magnetometer.	Time after "break."	Magnetometer.
0	0	0	13
5″	8	5″	5
60″	13	60″	0

* *Loc. cit.*, § 18, p. 537.

Adding to these the equivalent of the compensating coil, we see that just after the immediate magnetising force was suddenly applied, the value of the magnetism was 25, which increased after 5 seconds to 33, and after 1 minute to 38; and that when the magnetising force was suddenly withdrawn, there was at first a residual magnetism of 13, which fell to 5 in 5 seconds, and disappeared altogether in less than 1 minute.

Next a current 41 (producing a magnetising force of 0·084 C.-G.-S.) was made and broken in the same way. The compensating coil scarcely required to be moved from its former position, and its equivalent on the magnetometer was now 48. The column headed "total" gives the sum of the magnetometer reading, and the part balanced by the compensating coil.

Time after "make."	Magnetometer.		Time after "break."	Magnetometer.
	Observed.	Total.		
0	0	48	0	31
5″	20	68	5″	13
60″	31	79	60″	4

Here, out of the whole original residue of 31 a small part refused to disappear after the lapse of a minute, and it is probable that with this magnetising force some of the residual magnetism is permanent.

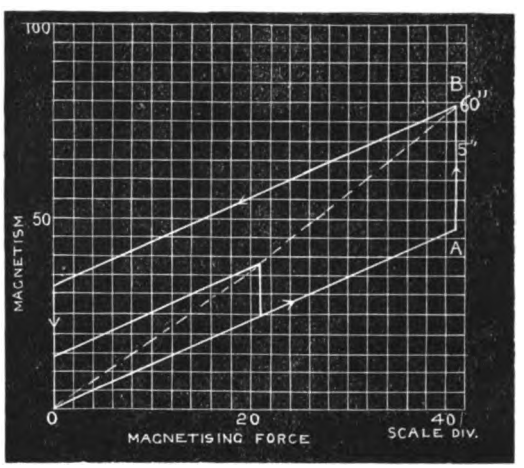

FIG. 1.

The above results are shown in Fig. 1, where the arrows indicate the sequence of magnetic changes. One scale division of the magnetometer is here equivalent to 0·0177 C.-G.-S. units of $\mathfrak{J}$ (intensity of magnetism). The magnetic force due to the solenoid may be taken as approximately equal to the whole magnetic force (although the rod was barely 100 diameters long, this length should be sufficient to approximate to endlessness when one is dealing with very low values of magnetic susceptibility). On this assumption, one scale division of the galvanometer is equivalent to 0·0021 of $\mathfrak{H}$; the initial instantaneous susceptibility, that is, the gradient $d\mathfrak{J}/d\mathfrak{H}$, is 9·9, and the initial instantaneous permeability ($d\mathfrak{B}/d\mathfrak{H}$) is 125. This value has been confirmed by a number of independent observations made with the same piece of annealed wire, and with another piece cut from the same hank and also annealed. Taking the magnetism acquired after 1 minute, the initial susceptibility as regards that is about 15.

Precisely similar results have been obtained by reversing feeble magnetic forces. So long as the forces are very small, the compensation for "reverse" is the same as for "make" and for "break," and the creeping of the magnetism in any given time after make, break, or reverse is nearly proportional to the amount of the preceding change of magnetising force.

In the following experiments the magnetising force was raised to higher values, at which this proportionality no longer held good. As before, the compensating coil was adjusted for each current to balance the effect of "make;" the iron was being demagnetised by reversals immediately before the "make." When a stronger current was applied, the coil had to be pushed

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nearer the magnetometer; but up to forces of 0·3 C.-G.-S. or so, it was practicable to secure an instantaneous balance by doing so. Observations of the drift were taken at 5 and 10 second intervals during 1 minute.* These are given on p. 273, the equivalent effect of the compensating coil being added in each case to the actual magnetometer readings.

In Fig. 2, curves are drawn to show the relation of the current to (*a*) the immediate magnetisation; (*b*) the magnetism after five seconds; and (*c*) the magnetism after one minute. The gradient of the curve (*a*) at and near the origin is the same as that of the corresponding curve in Fig. 1, when allowance is made for difference of scales. In the present instance one division of current is 0·0013 of $\mathfrak{H}$, and one division of magnetism is 0·008 of $\mathfrak{A}$. The gradient begins to increase very sensibly when $\mathfrak{H}$ exceeds about 0·07.

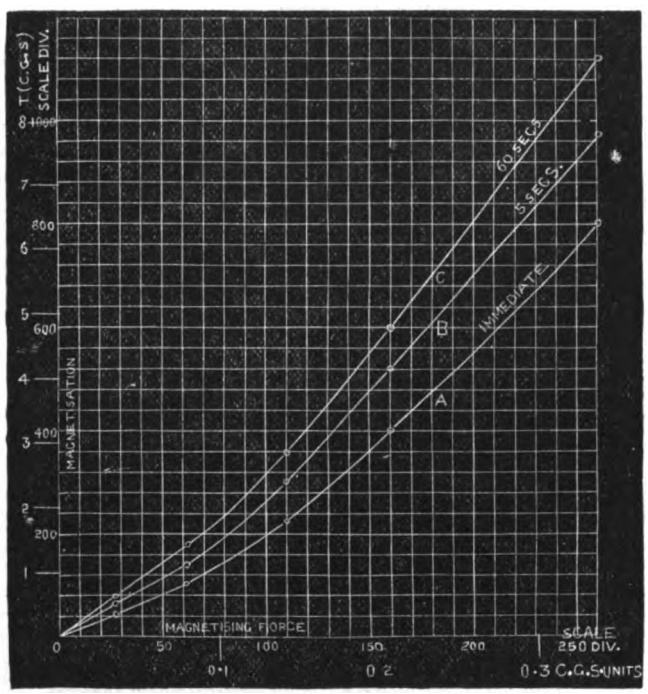

FIG. 2.

Some of the results of Table I are also shown in Fig. 3, which gives time curves of the growth of magnetism for the first two stages (currents 27 and 62). Similar curves for the other stages may readily be constructed from the table. It should be noticed that the time rate of creeping is by no means excessively great in the first instants after contact is made; it is on this fact indeed that the practicability of the method depends.

TABLE I.

Time after "make."	Current.				
	27	62	110	161	161
Seconds.	Magnetometer + comp. coil.				
0	47	107	224	395	798
5	65	145	304	525	974
10	72	159	327	560	1071
15	74	165	339	573	1089
20	77	169	344	581	1098
25	79	171	347	586	1104
30	79	173	350	590	1109
40	80	175	354	595	1116
50	80	177	355	598	1120
60	80	177	357	600	1124

Similar differences between the immediate and ultimate increments of magnetism present themselves when the magnetising force is increased step by step. In the following experiment the compensating coil was set so as to balance the immediate effect of a feeble magnetising current. Then such a current was applied, and the creeping up of the magnetism during one minute was observed. At the end of the minute the current was increased by a small step, and it was found that the compensation was still correct or very nearly so; in other words, that the immediate effect of this small increase of magnetising force bore the same or very nearly the same proportion to the increment of force as at the beginning of the process of magnetisation. The creep up of magnetism was again observed during a minute; then another small step up of the current was made, and so on. The compensation remained nearly correct for a number of steps, but as the process was continued up the curve of magnetisation, it became apparent that the immediate effect was *increasing*; in other words, that there was under-compen-

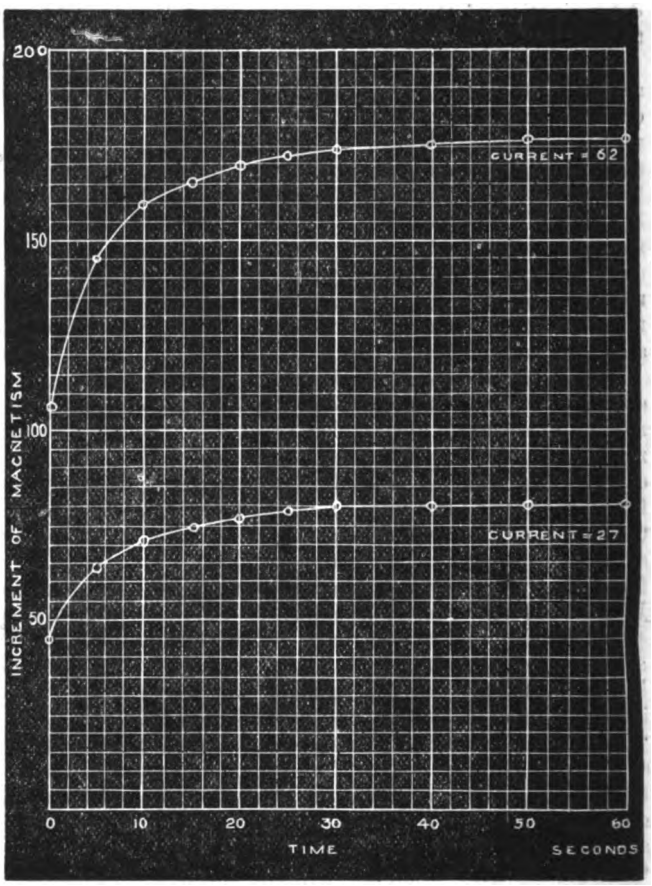

FIG. 3.

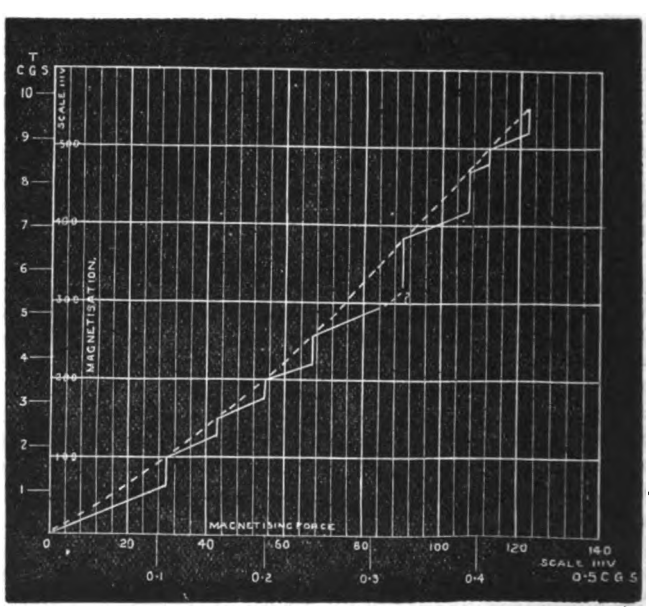

FIG. 4.

* To make the drift large the top of the wire was this time only 4 centimetres from the magnetometer.

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sation, and that the compensating coil would have to be moved a little forward if an exact balance was to be maintained. The results of this experiment are given below (Table II.), and are exhibited in Fig. 4. The magnetising current was increased from one to another of the successive values shown in the table at intervals of one minute in each case by moderately quick movements of the sliding block in the liquid rheostat. The changes of magnetic force were, therefore, not quite sudden; each of them took, perhaps, a quarter of a second to complete.

TABLE II.

Magnetising current.		Immediate magnetic effect of step.	Additional increase of magnetism in 1 min.	Total magnetism after 1 min.
Step.	Total.			
30	30	63	36	99
13	43	27	23	149
14	55	26	22	197
12	67	25	35	257
23	90	(49+)	(75−)	381
17	107	36	53	470
5	112	10	22	502
10	122	21	33	556

The step of 23 was too large to have its immediate effect balanced by the compensating coil in the position in which the coil was set. The magnetic effect of such a large step is conjecturally shown by the broken line marked (?) in Fig. 4. It will be noticed that the points reached after one minute at each step lie well on a continuous curve, which is shown by a dotted line in the figure.

In Table II. and Fig. 4 one scale division of magnetising current is equivalent to 0·00362 C.-G.-S. units of magnetising force, and one scale division of the magnetometer is equivalent to 0·0177 C.-G.-S. units of $\mathfrak{I}$. The immediate value of $d\mathfrak{I}/d\mathfrak{H}$ is about 10, as before, and this applies approximately throughout the range of magnetism dealt with here, with a slight increase towards the upper end of the range.

Higher up in the curve of magnetisation, however, the immediate effect of a small, quick increment of magnetic force is greater, though then (owing to the greater steepness of the curve $\mathfrak{I}$ and $\mathfrak{H}$) it bears a smaller proportion to the ultimate effect. This is well shown in the following experiment (Table III. and Fig. 5).

TABLE III.

Magnetising current.		Magnetising effect.	
Step.	Total.	Immediate.	Additional in 1 min.
...	461	...	...
15	476	19	61
13	489	17	55
11	500	14	50
15	515	19	69
32	547	(41+)	(142−)

Here the last step was too large for perfect compensation. One scale division of current corresponds to 0·0021 C.-G.-S. units of magnetising force, and one scale division of the magnetometer corresponds to 0·022 of $\mathfrak{I}$. The immediate susceptibility to small increments of force, $d\mathfrak{I}/d\mathfrak{H}$, is now about 13. The magnetic viscosity is now so great that this immediate effect is less than one-fourth of the whole change which the magnetisation has suffered by the time 1 minute has elapsed.

To show clearly the region in the curve of magnetisation at which the experiment of Table III. and Fig. 5 was made, a curve is drawn in Fig. 6, showing, as the result of a separate experiment, the relation in absolute measure of the intensity of magnetism to the magnetising force produced by the solenoid. The region dealt with in Table III. is at the place marked Q ($\mathfrak{I}$ = about 40 C.-G.-S.), and the dotted line drawn there shows the immediate value of $d\mathfrak{I}/d\mathfrak{H}$ after a 1-minute pause. The dotted line P shows the corresponding initial gradient, or immediate value of $d\mathfrak{I}/d\mathfrak{H}$, when there is no previous magnetisation.

Another step-by-step experiment of the same kind, made at a place higher up, where the magnetising force of the solenoid was about 4 C.-G.-S. and $\mathfrak{I}$ about 320, gave again about 13 for the immediate effect ($d\mathfrak{I}/d\mathfrak{H}$); and this was followed by a creeping to the extent of six or seven times the immediate effect.

The immediate magnetic effect of a small step is substantially the same whether the step is made quite suddenly by short-circuiting a resistance coil in the circuit of the magnetising solenoid, or comparatively gradually by means of the liquid slide, so that the process occupies a sensible fraction of a second, or even as much as a whole second.

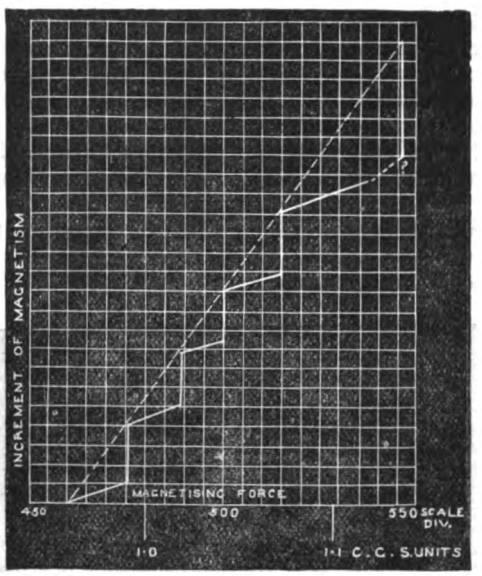

FIG. 5.

However small the step is, it appears to be followed by a creeping up of magnetism. I have been able to discover nothing which would correspond with the limit of perfect

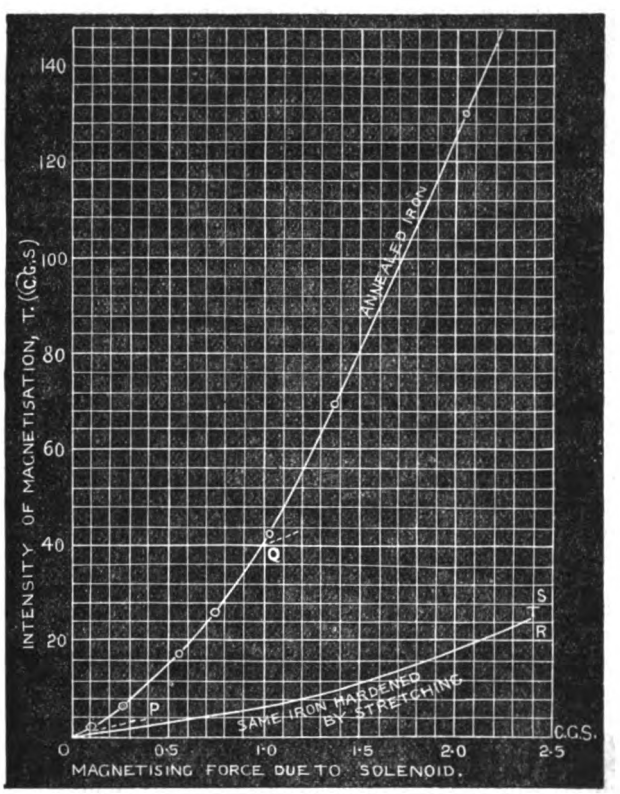

FIG. 6.

elasticity in straining a solid (if there be any true limit of elasticity), either in the initial part of the process of magnetisation, or after the prolonged application of a constant magnetising force.

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But the prolonged application of a constant magnetising force produces an effect which is a most interesting analogue of one effect of prolonged loading in a stretched wire. It is well known that when a load (sufficiently great to produce permanent set) is applied to a stretched iron wire, there ensues, with the lapse of time, not only a certain amount of supplementary viscous extension (the analogue of the magnetic creep), but also a quasi-hardening of the metal which becomes manifest when an addition is made to the load.* One effect of this is that the wire responds with great sluggishness to the additional load, and this sluggishness is greater the longer has been the preceding interval during which the load has been maintained constant. To test whether, in like manner, the prolonged application of a constant magnetising force would produce what may be called magnetic hardening, I have made comparative observations of the time-rate of change of magnetism when a definite small increment of force is applied, the preceding force having been kept constant (*a*) for a short time and (*b*) for a long time. The result is to show that the process of magnetic creeping after a small step is much slower when the preceding force has been in action for a long time than when it has been in action for only a short time.

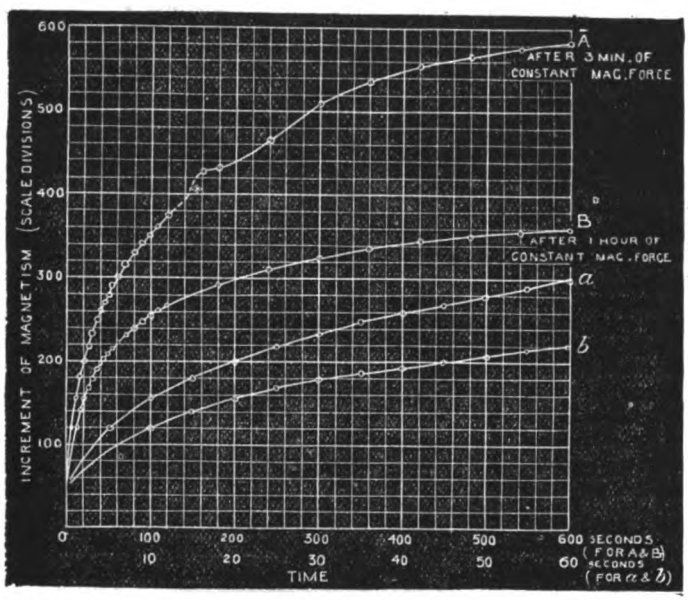

FIG. 7.

The following experiment illustrates this well. After raising the magnetising force to between 2 and 3 C.-G.-S. units, the compensating coil was adjusted to balance the immediate effect of a small increase of force, this increase being brought about by short-circuiting 1 ohm (out of many ohms) in the magnetising circuit. When the compensation had been adjusted, the iron was demagnetised by reversals, and the magnetising force was again gradually applied. When it reached the value of 2·54 C.-G.-S., a pause was made for 3 minutes, during which time this magnetising force of 2·54 remained constant. The resistance in the circuit of the magnetising current was then suddenly reduced by 1 ohm, which had the effect of raising the force to 2·60. The compensating coil prevented this step-up of magnetising force from having any instantaneous effect on the magnetometer; but creeping, of course, began at once, and the time-rate of creeping was observed during 10 minutes. Then the magnetising current was kept constant for 50 minutes more, making 1 hour in all, and a second step-up of magnetising force was effected by removing another ohm of resistance: the second step was very nearly equal to the first, and raised the force to 2·66 C.-G.-S. The time-rate of creeping which followed it was also observed during 10 minutes. The results are shown in Fig. 7, where the curve A shows the growth of magnetism during 10 minutes when the step had been preceded by a 3-minute interval of constant force, and the curve B shows the growth of magnetism when a sensibly equal step was made, which had been preceded by a 1-hour interval of constant force. The times are in each case reckoned from the instant at which the step was made, and the increment of magnetism is in each case reckoned from the value reached just before the step was made. The immediate effect of each step (balanced by the coil) was equivalent to 51 scale divisions of the magnetometer. The creeping-up in 10 minutes was equal to no less than 531 scale divisions in the case of curve A, as against 320 in curve B. At the place marked with an asterisk in curve A, it happened that the laboratory door was slammed, which shook the wire very perceptibly and caused a comparatively sudden increase of magnetism (indicated by the dotted part of the curve), after which the time-rate of creeping became specially slow for one or two minutes; finally, however, the rate appeared to recover from this disturbance. The curves *a* and *b* of Fig. 7 are the first parts of A and B drawn to a ten-fold coarser scale of times.

In confirmation of the above, another experiment was made, in which the magnetic force was increased by three successive small and very nearly equal steps. The first step was made after 5 minutes of constant force, the second after 1 hour of constant force, and the third again after 5 minutes of constant force. Time-curves of the growth of magnetism were drawn in all three cases. The first and third curves were not far from coincident; but the second curve lay very much below them, as B lies below A.

In the experiments to which Figs. 4, 5, and 7 relate, the increment of magnetic force whose effects were measured was preceded by increasing magnetic forces; in other words, it was a step-up from a point on the *up* curve of magnetisation. I have also examined the effect of a small *step-down* from a point on the up curve—that is to say, a small decrement of previously increasing force—and find, as might perhaps be anticipated from what we knew about static hysteresis, that the immediate effect ($d\mathfrak{I}/d\mathfrak{H}$) of a step-down is decidedly less than the immediate effect of a step-up. When the compensating coil had been adjusted to balance the first effect of a step up, it was found to give over-compensation for a step-down.

Another process has been examined, namely, the alternation of a step-up with step-down, many times repeated. After the magnetising current had been raised to a certain value, it was periodically altered through a definite narrow range by alternately putting in and pulling out the short-circuit plug of a small resistance coil in the main circuit, or by making and breaking a feeble circuit in a second solenoid wound over the first. It was only when this process had been repeated many times that the magnetic effects of the small changes of $\mathfrak{H}$ became approximately cyclic; the early cycles were associated with a progressive rise in the intensity of magnetism. But when a nearly cyclic state was reached, the compensating coil could be adjusted to balance the immediate effects of $+\delta\mathfrak{H}$ or $-\delta\mathfrak{H}$, and the same adjustment, of course, served to balance either.

Tested in this way the gradient $d\mathfrak{I}/d\mathfrak{H}$ (for the immediate effect of $\delta\mathfrak{H}$ after many small + and − steps) has, of course, a lower value than the gradient which is found when $\mathfrak{H}$ is first raised to $\mathfrak{H}+\delta\mathfrak{H}$). The latter, as we have seen, is greater when the magnetisation is moderately strong than when there is little or none. The former is nearly constant throughout a wide range of $\mathfrak{I}$; its value is approximately the same as at the initial part of the magnetisation curve—namely, 10—until the region of saturation is approached, when it becomes distinctly less.*

The periodic changes of magnetism which are brought about by successive small increments and decrements of $\mathfrak{H}$ exhibit a lagging and creeping up and down precisely similar to that which has been illustrated in Fig. 1. That figure may serve to show in a general way the relation of the change of $\mathfrak{I}$ to the change of $\mathfrak{H}$, when at any place in the curve a very small increment $\delta\mathfrak{H}$ has been applied and removed often enough to establish a cyclic *régime*. I have not made any full examination of the variation which under these conditions the gradient $d\mathfrak{I}/d\mathfrak{H}$ suffers when the magnetism on which the small cycle if superposed is gradually pushed up towards saturation, nor of the proportion which the subsequent creeping up or down

* *Cf.* Roy. Soc. *Proc.*, No. 205, 1880, or *Encycl. Brit.*, art. "Strength of Materials."

* *Cf.* Lord Rayleigh, *loc. cit.*, on the approximate constancy of the *static* gradient $d\mathfrak{I}/d\mathfrak{H}$.

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bears to that part of the change of $\mathfrak{J}$ which occurs immediately on the application or removal of $\delta\mathfrak{H}$. The creeping which follows each repeated application and removal of $\delta\mathfrak{H}$ is certainly much reduced when the iron approaches saturation; but the immediate effect is also reduced, and so far as may be judged by rather rough determinations, it appears that the proportion of creeping to immediate effect is much the same with high as with low magnetisation.

One may refer, in this connection, to the energy which is dissipated through hysteresis, in performing a small cycle by alternately applying and removing a very small force $\delta\mathfrak{H}$. The action is the same in kind whether there is or is not additional magnetisation. The energy dissipated in each cycle is $-\int \mathfrak{J}d\mathfrak{H}$, and vanishes when the increment and decrement of go on *pari passu* with the increment and decrement of $\mathfrak{H}$.

Consider now Fig. 1. When the repeated cyclic changes of $\mathfrak{H}$ are indefinitely rapid and go on without pause, so that creeping has not time to occur, a single straight (or sensibly straight) line such as O A represents the relation of the change of magnetism to the (very small) change of magnetising force, during both increment and decrement. The rapidity of the action prevents any loop from being formed, and there is consequently no sensible dissipation of energy through hysteresis. This state of things is perhaps nearly realised in the case of a vibrating telephone diaphragm, or, in regard to circumferential magnetisation, by an iron conducting wire in a telephone circuit. Again, let the cycle be performed indefinitely slowly. In that case the magnetism, at every stage of the cycle, creeps up or down to a steady value. A sensibly straight line, such as O B, represents the relation of $\mathfrak{J}$ to $\mathfrak{H}$ during both increment and decrement; and there is again no dissipation of energy. But with any frequency of alternation lying between these extremes of infinitely fast and infinitely slow, a loop will be formed, since the creeping will take effect most considerably at and near the ends of the range (the time rate of change of $\mathfrak{H}$ being least there), and there will be dissipation of energy. When the limits and mode of variation of $\mathfrak{H}$ are specified, there must be some particular frequency which will make the energy dissipated per cycle a maximum.

The phenomena described in the Paper have been reproduced in several specimens of annealed iron wire, of course with quantitative differences. As to the amount of magnetic creeping, much depends on the annealing of the specimen. Another piece of iron wire cut from the same bundle as the piece with which these experiments were made, and annealed at another time, showed almost exactly the same susceptibility to magnetism as the first piece, so far as immediate effect went; but in it the subsequent creeping up was decidedly less (in the proportion of about 4 to 5).

When the iron is hardened by mechanical strain the phenomena of creeping vanish almost completely. A specimen from the same bundle was annealed, and showed much creeping. It was then put in the testing machine and pulled until it took a set of 1 or 2 millimetres in a length of 40 centimetres or so. It was then examined magnetically as before, and scarcely a trace of creeping could be observed when a feeble magnetising force was applied. When the compensating coil was properly adjusted the making or breaking of the magnetising current caused no more than a slight momentary quiver of the magnetometer needle, followed by no measurable drifting, although the whole magnetic effect (compensated by the coil) was equivalent to a hundred or more scale divisions. When a magnetising force of as much as 0·6 C.-G.-S. units was suddenly applied, the amount of creeping, if there was any, was certainly less than 1 per cent. of the immediate effect. With values of $\mathfrak{H}$ higher than this it became possible to detect creep with certainty. The following notes relate to this wire :—

Magnetising force suddenly applied. (C.-G.-S.)	Immediate value of $\mathfrak{J}$ (C.-G.-S.)
0·75	4·49
1·28	8·42, crept in 1 min. to 8·58
2·40	25·5 „ 26·4

These forces were in each case applied to this wire in a neutral state. Another trial of the same, with feebler forces, gave 5·3 as the value of $d\mathfrak{J}/d\mathfrak{H}$ for the immediate effect of a very small force, applied when the iron was demagnetised. The same quantity in the annealed specimen was, as has been said, about 10. In Fig. 6 the relation of $\mathfrak{J}$ (immediate) to $\mathfrak{H}$ as stated above, is represented by the curve O R; the creeping up at the last point is R S.

In speaking of soft iron it has been shown that the effects of creeping are most marked when a small addition $\delta\mathfrak{H}$ is made to a previously increasing force $\mathfrak{H}$. In instances quoted above, the creeping up in 1 minute has under those conditions been many times greater than the immediate effect of $\delta\mathfrak{H}$.

By way of putting the specimen of hardened iron to the same test, I have applied a magnetic force of 1·46 and raised it by a small step to 1·49. The immediate effect of this step (which was balanced by the compensating coil) was equivalent to twenty-two scale divisions of the magnetometer, and this was followed during 1 minute by a creeping equal to six scale divisions. In itself this creeping is considerable, but compared with the corresponding creeping in soft iron it is extremely small.

Pieces of steel (containing a good deal of carbon) have also been examined, with the result that whether the steel be annealed or in its commercial temper the phenomenon of creeping is even less visible than in hardened iron. With annealed steel, a force which produced an immediate (compensated) magnetic effect equal to 124 scale divisions caused barely a single scale division of creeping. With a stronger current, giving an immediate magnetism of 340, the subsequent creeping was 3. In steel and in hard iron the creeping seemed to be completed in a few seconds after the institution of the magnetising current. The steel specimen, like the iron, had a diameter of rather more than 4 millimetres. Its susceptibility (annealed) was considerably less than that of the iron in the hard state.

It is scarcely necessary to observe that the protracted and extensive creeping or magnetic "nachwirkung" in soft iron which these experiments illustrate cannot be ascribed to the subsidence of the circumferential currents which are generated by the imposition of longitudinal magnetic force. The creeping is equally conspicuous whether the magnetic force is suddenly or gradually imposed. Lord Rayleigh has shown that circumferential currents started and left to themselves will subside to e^{-1} of their initial magnitude in the time

$$\tau = \frac{4\pi\mu a^2}{(2{\cdot}404)^2\rho},$$

where a is the radius of the cylinder, μ its permeability, and ρ its specific resistance.* In the present instance, taking the case of the annealed iron rod, $a = 0{\cdot}202$, $\mu = 125$, $\rho = 9827$ (Everett), and τ is less than $\frac{1}{1000}$th of a second. The subsidence would be practically complete in a small fraction of a second; but the creeping persists during many seconds and even minutes with no excessive change of rate. Again, comparing soft iron with hard iron, in which μ is less and ρ is greater, the values of τ will differ, but not by any means so much as to correspond with the very wide difference in magnetic lag.

In view of this it is puzzling to find that the diameter of the rod experimented upon has a most important influence on the magnetic lag.

In testing various samples of soft iron wire, most of which were of less diameter than the piece used in the above experiments, I noticed that the phenomena of creeping were less marked in the smaller rods. I then tried a bundle of nine very soft annealed iron wires, which were bound together with fine copper wire, and formed a core of about the same length and aggregate diameter as that of the solid rod formerly used. With this bundle there was some creeping, but very little in comparison with what was observed in the solid rod, as the figures in the table on the following page will show.

Finally, another bundle was built up, consisting of a much larger number of fine annealed iron wires. With this the creeping was almost insensible.

It may be that the comparative absence of magnetic creeping, or "nachwirkung," in these last experiments is to be ascribed

* "Brit. Assoc. Report," 1882, p. 446.

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to the quickness with which the process of creeping completes itself in a finely-divided mass of iron; in other words, that the process is practically complete in a time much shorter than the period of the magnetometer needle. The marked difference in effect between a solid core (a single thick wire) of soft iron and a laminated core (a bundle of fine wires) of the same material suggests that in the former much more than in the latter the process of creeping is retarded by the eddy currents which are set up by those molecular movements in which the process itself consists.

Bundle of Nine Soft Iron Wires.

Magnetic force ℌ suddenly applied (C.-G.-S.).	Magnetometer deflections.		
	Immediate (balanced by compensating coil).	Subsequent creeping in 1 min.	Total in 1 min.
0·052	17	2	19
0·147	52	9	61

[July 11th.—In seeking an explanation of the difference in behaviour it may be worth while to bear in mind that there is probably a considerable difference in molecular structure between a solid core and a laminated core of iron. If we accept the view that the magnetically neutral state is due to the molecular magnets forming closed rings, these rings will for the most part be closed within the limits of the separate constituent pieces of the laminated core, whereas in the solid core they may be much larger, their dimensions being limited only by those of the core itself.]

I have received very valuable help in these experiments from two students, Mr. David Low and Mr. William Frew, who have prosecuted a troublesome research with much patience and zeal.

PRECAUTIONS TO BE ADOPTED WHERE A SUPPLY OF ELECTRICITY IS FURNISHED BY MEANS OF TRANSFORMERS.*

BY KILLINGWORTH HEDGES, M.I.C.E.

In a Paper entitled the "Fire Risks of Electric Lighting," which was read at the meeting of the British Association held in Southport in 1883, I brought forward for the first time the necessity of electric light regulations and the use of safety appliances. The fire insurance companies have almost universally recognised that the electric light can only be considered a safe illuminant when the strictest attention is paid to the details of an installation; and the regulations which have been published by the principal companies and by the Institution of Electrical Engineers have so far proved successful, as no fire of magnitude can be traced to the electric light. The introduction of transformers has led to the increase of the electromotive force in the primary mains, and there appears to be a tendency to decrease the pressure in the secondary, consequently there is an enormous difference of potential between the two systems and a constant strain on the insulation of the transformers. A transformer may be compared to the reducing valve which converts high-pressure steam into the safe pressure for working heating coils. There is, however, this difference—a transformer never sticks like a valve, but it sometimes leaks, and the consequences are similar to those arising from a leaky reducing valve. Supposing a small leak to take place between the primary and secondary coils, it is quite possible that a small current of dangerously high potential might be introduced into the secondary circuit, which would make very little difference to the light from the lamps, but might cause fatal results on any one inadvertently touching some unprotected portion of the wires or fittings with one hand and a gas pipe with the other. To produce this effect it is necessary that some earth should occur on the primary main or mains. With the overhead wires which have almost universally been employed, with alternating currents of high E.M.F., any leakage to earth may be avoided, but with an underground system, and with the increased pressure which is about to be introduced, there is sure to be some earth connection; in fact, with the Ferranti system, one of the conductors is to be earthed throughout. Allowing that a possible danger exists, the question is to find a safe preventive, and with this object it is proposed to briefly recapitulate what has been done. Mr. Kent inserts a metallic shield between the primary and secondary coils of the transformer; this sheet of metal is connected to earth. Now, if the insulation of the primary coil should fail, the leak before reaching the secondary coil must pass through the sheet of metal and thus to earth, causing the primary cut-out to melt and thus cutting out the faulty transformer. The next plan is still simpler, and is to earth the secondary circuit, so that the effect of a contact in the transformer would be to establish connection through the earth and to blow out the primary fuse as in the previous method. It has been stated by several high authorities that this arrangement is all that is wanted to secure perfect safety against shock, but the question of fire risks has also to be considered, and these would be greatly increased, also the insulation of the wires in houses would have to be of the most expensive character. Allowing that every care had been taken with the insulation, the proximity of gas and water pipes in a house to the wires, which are often laid under floors, might open a path for the deviation of a leakage current, say of 2,000 volts or over, and an arc once formed would result in a dangerous fire. The fire insurance offices have not sanctioned this plan, which does not even appear to be used in those go-a-head institutions, the electric light companies of the United States, who apparently employ no safeguards, and trust to Providence with regard to the "burn out" of a transformer, having a ready supply of duplicate parts to at once replace in the faulty instrument. We now come to the intermittent earth device, that is the automatic apparatus which only comes into play when the potential in the secondary has dangerously increased. Dr. Fleming has described an instrument which consists of a fine-wire safety catch holding down suitable contact pieces in mercury cups against the pressure of a spring. The safety catch would be arranged to stand the normal difference of potential between the two secondary mains, but as soon as that rose beyond a certain amount the circuit would be automatically broken. This plan has the disadvantage of a certain amount of loss of current, which would be, however, checked by a resistance; but it avoids the necessity of using an earth.

Fig. 1.

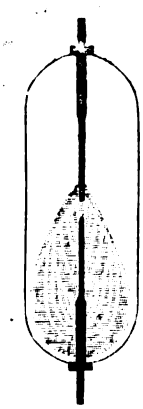

Fig. 3.

Bernstein advocates his contact plug, which contains a substance, the resistance of which can be made enormous with the normal current, but the heating effect of an increasing current causes the mixture in the plug to be decomposed, and a metallic circuit established. I am unaware whether this has been tried in a circuit from a transformer or not, but am afraid it would not answer in practice. Major Cardew, whose improved apparatus I have the pleasure of showing you to-day, has, so far, produced the most successful device. It has been called the static mouse-trap (*see* Fig. 1), in that it goes off directly an unauthorised volt enters it. The arrangement which you see on the table takes the form of a box; in it there are two brass discs, separated one from the other by an insulating washer of ebonite. Between the two discs is placed a small strip of

* Paper read before the British Association in Section G, Newcastle-on-Tyne, September, 1889.

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aluminium foil which lies in ordinary on the lower disc, which is connected to earth. The other disc is in connection with the secondary coil of the transformer, and should any leakage take place from the primary so as to raise the potential in the secondary say by 50 per cent., that part of the aluminium foil which is under a projection on the upper disc will be attracted to it, making an electrical connection and starting an arc which short circuits the secondary and causes the primary fuses of the transformer to be melted. Working quite distinctly from Major Cardew, I have also designed a safety appliance, which may be called a "vacuum cut-out." It is on the lines of those lightning protectors which are often used with telegraph cables, but the electrodes are fixed at each end, and cause the current on its way to earth, after leaping across the points, to energise an electro-magnet which releases a short-circuiting device connected with the primary poles of the transformer (Fig. 2). There is one great advantage in my vacuum cut-out, in that it is not affected by dust or moisture, which might impede the static arrangement. In practice, I propose using old incandescent lamps, with their broken filaments sprung, as they often are, one-sixteenth apart. The perfect vacuum must, however, be destroyed, or only high potential will pass, and the current will preferably short circuit across the terminals instead of leaping across the broken filament. A lamp of this description would cost very little, and could be fixed in the same manner as the Cardew cut-out, without any relay. Numerous experiments were made to ascertain the distance which an alternating current would leap across points in tubes exhausted to a certain amount. The results differed considerably from the figures given by De la Rue in his experiments with continuous currents. In one experiment with glass cylinders having conductors hermetically sealed in opposite ends, and with a pressure of 5m/m, less than that equal to a perfect vacuum, an alternating current of 1,000 volts invariably passed between the ends of the copper electrodes, which were ·3 inches apart.

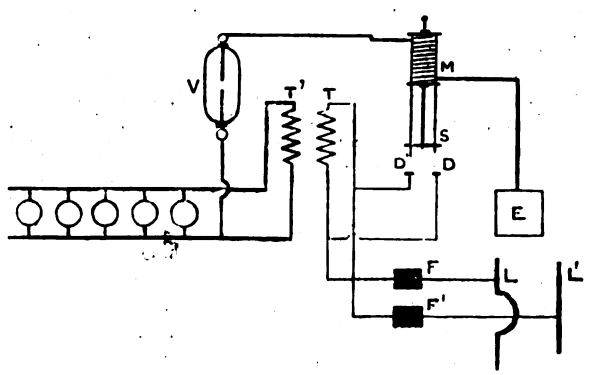

FIG. 2.—V, vacuum cut-out; M, electro-magnet; S, short circuiting device; D D¹, stops for ditto; E, earth; F F¹, fuses; L L¹, main leads; T T¹, transformer coils.

The arc (Fig. 3), however, did not remain steadily at the ends, but would first run down one electrode to the point where it was connected to the platinum wire, which came through the glass, with the result of fusing it away. The arc would at the same time extend almost to the glass, although the opposite electrode was left intact. The reason of this phenomenon with an alternating current may be perhaps explained in the discussion. In conclusion, I think that all those who intend using high-tension alternating currents for the supply of electric light and power, should be obliged to fix a safety device on the secondary circuit, near the transformer, with the object of not only protecting their own property, but also to do away with the possibility of an unauthorised current being inadvertently led into a building so as to endanger the lives of the public.

DISCUSSION.

Mr. PREECE had one word to say as regards the dangers. When he spoke the other day he referred solely to dangers to persons, but to-day they had heard more about dangers from fire. It was a great mistake to imagine that an electric lighting system was entirely free from risks of fire. It was often said, "Oh, have the electric light in your house and you will be absolutely safe; there is no fear of your house being burnt down." But that was a very great mistake. There was not the slightest doubt about it that there was nearly as much danger—not quite—from introducing the electric lighting as there was from introducing gas. Gas, of course, was much more dangerous, but there was danger in introducing the electric light, and the chief danger arose from the use of imperfect material, and especially from the employment of inexperienced men, and also from the want of just those very contrivances which Mr. Killingworth Hedges had brought before the Section. If good material was used, if experienced men were employed to lay down wires, and if all the apparatus of safety such as they had heard of from Mr. Hedges be admitted, then electric lighting is absolutely safe, but not unless they did something of that sort of thing. As regarded dangers to persons, that was quite a different thing. He had alluded the other day to a strange remark made by Mr. Stephenson. One of the reasons he had adduced against the distribution of power by means of electricity was that if a man touched the wire he would be killed. Well, in unscientific language, that is absolute rot. The difficulty with electric currents is not to prevent them from killing, but to kill a man. The State of New York recently passed an Act making execution in the future execution by electricity. They had not rescinded that Act yet, but they would be obliged to do so, because they could not determine the electric current which would kill a man with certainty. He remembered on one occasion making some experiments with an enormous induction coil by Apps. They did all they could with a spark 20in. long to kill a rabbit, and they could not. They volunteered to try him, but he was not quite ready to offer his body when other animals could be found. There were many who had taken immense shocks. Colonel Armstrong at Chatham took shocks that were supposed to kill individuals, but he was very well afterwards. He could really say this from some experience of electricity, that with ordinary precautions there absolutely is no danger to person, there is no danger to life, and much that is said about it is nonsense. Newspaper correspondents, as a rule, were very fond of getting up sensational paragraphs, and the newspapers very often put them in. There was a case in Brighton only three weeks ago, where a brewer's man was stated to be killed by the electric light currents. Certainly the man was dead; he was found resting against a wire; there was a mark on the back of his neck which showed some indications that he might have been killed by electricity. But the fact was that the electric light current was stopped some two hours before the man was supposed to be killed, so that when the man was killed there was no electric current from the electric light station. There might have been lightning—there was a thunder-storm at that time—but it is doubtful whether the man in Brighton was killed by currents generated by the central electric lighting station established there.

Mr. KILLINGWORTH HEDGES, in reply to Mr. Powell, said he did not mean to say in his Paper that the fire risks were greatly increased; he had meant to say that they were practically settled, and that the dangers could be minimised by the precautions which the insurance offices insist upon before they pass the insulation. He thought something the same would eventually be done with the question of danger through shocks. He was rather in the position of the rabbit described by Mr. Preece. He had had a very severe shock, and had been told that he had made a great mistake. He thought Mr. Preece could hardly have meant that the insulation of an underground system was perfect. He happened to have with him the discussion on a Paper read in 1888 on the distribution of electricity by means of secondary generators and transformers. In the discussion Major Cardew said that the subject had given anxious consideration to the Government, in that the conductors with transformer systems may acquire at any time a potential difference of 2,400 volts from the earth, and that in all underground mains there is a resultant leak. Therefore, as the other conductor has also a resultant leak, and this is not likely to offer a resistance of many thousand ohms, there is a danger that, if conditions are favourable, the whole system of transformers may break through, and hence prevention is better than cure—one should be prepared for this. I do not mean to say that it is going to occur at once, but I think one ought to admit that there is this chance, and try some special device. As regarded the mains of the London Electric Supply Company, the shareholders were to be congratulated that the system, beautiful and ingenious as it is, is not going to be used now, because it seemed too much of an experiment to lay down that enormous amount of main on quite a new system, and a system which he thought had never been tried experimentally.

Junior Engineering Society.—Prof. Perry has accepted the presidency of the Junior Engineering Society for the ensuing (the ninth) session, which he will inaugurate by the delivery of an address on "Mechanical Engineering in Electrical Industries." This lecture will be delivered on Friday, October 11, at the Westminster Palace Hotel.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September* 14, 1889.

The Postal Telegraph Company, which, as you are aware, has Mr. John Mackay behind it, has been very busily engaged for a long time in developing its service on the Pacific Slope. It now proposes building lines through Oregon and Washington Territory, connecting interior points with the large cities on the Pacific. This work will be begun early next spring. At the present time the company is actively occupied also in developing its service through the South, and it is stated that it will spend over four million dollars this year in Southern States. One of the lines to be built will run along the Atchison, Topeka and Santa Fé road to the Pacific Coast. The company will also probably buy up one or two of the smaller companies which exist in the South, and will thus only follow the example of the Western Union Company, which has but just recently completed such a purchase. Mr. Mackay has been in this city for some time past, occupied with the affairs of his company, and with the Commercial Cable Company, whose capital stock has been increased from $6,000,000 to $10,000,000, and is now going on the Stock Exchange, where its friends expect to see it rank with other established 6 per-centers.

The subject of electric railways is fast becoming a leading one in many of our Western cities. The example that Boston has set in going in boldly for electricity as the motive power for its street railways has very effectually arrested the attention and stimulated the enterprise of Western street-railway magnates, and the consequence is that we see a large quantity of new work and hear of more very big projects. Last week I mentioned what is being done in Cincinnati. The same activity prevails at Cleveland, Ohio, and other places. St. Paul, Minnesota, determined not to be left behind, has gone in at a great pace, and last week granted ordinances to no fewer than four companies. A peculiarity of one of these franchises is that it is granted to Archbishop Ireland, of the Roman Catholic Church, and it is supposed that this well-known dignitary proposes to invest church funds in the enterprise. This is wholesale work, but, as in the case of Boston, the city newspapers approve the action, and there is no doubt that St. Paul will soon have several fine roads running. At St. Louis electric roads are beginning to attract considerable attention, and while this city has been considered one of the strongest centres of cable-road influence, it seems more than likely that ere long it will be just as much an electric city. One of the reasons why the cable roads in operation there were so popular and successful was that they competed with parallel horse roads. As soon, however, as these parallel lines were cabled, the more enterprising companies saw that the public wanted further improvements, and they are thus about to adopt the electric motor, not simply because it will afford better transit facilities, but because it will serve to cut down operating expenses.

It is becoming the practice here to introduce the electric light in the various State institutions, prisons, &c. The best results have attended this improvement, and it will not be long before such places without the electric light will be the exception rather than the rule. One of the latest instances of the kind is that at Michigan City, Ind., where the incandescent light has been adopted for the Northern Indiana Penitentiary. There are 700 cells in this place. Hitherto the prisoners have been allowed candles, each of which, of course, had its attendant danger, and had to be extinguished individually. Now, however, the lights will all be extinguished at once, and "on time," and there will be less fear and probability of fire, while the cells will be more healthfully illuminated.

As might have been expected, the Harold P. Brown revelations have caused considerable talk, and are still the prevailing sensation. Mr. H. P. Brown has offered $1,000 reward for the recovery of his letters that "gave the thing away," and for the detection of the person who stole them. It is remarked by some, however, that Mr. Brown lost something else besides his letters, and offers no reward for that, either considering it irrecoverable or of no value. It is now considered that as the result of these disclosures, amounting, it is claimed, to a conspiracy against the Westinghouse Company, the Kemmler investigation will be reopened, in order that the documents in the case may be made a part of the official record, possibly with interesting supplements and addenda. It is not now very generally believed that the sentence of capital punishment by electricity will be enforced, and the sentiment on the part of the public seems to be that death by electricity would not be the altogether painless and stainless euthanasia that has been depicted. It is somewhat significant that Dr. Peterson, who last year was associated with Mr. Brown in his experiments, has come out in a Paper before the American Science Association, offering some very striking reasons why electrical death is objectionable. He says that the most cogent argument that he can urge against electricity as a death penalty is the complexity of the apparatus required, in comparison with the simple instruments used in hanging and beheading, and shows how numerous the conditions necessary for success are, even outside the apparatus.

The National Telephone Association meets in convention this week at Minneapolis. The attendance will be by no means as large as that at the National Electric Light Association at Niagara Falls, but in its way it will be representative of the great industry that telephony has grown into in this country. As you are probably aware, this Association represents the licensed telephone companies doing business in various parts of the country, and it would be interesting to know just what view the parent company in Boston takes of their proceedings. From all outward appearance, however, the relations have been maintained on a social and friendly basis, and for some time to come they will probably remain that way. It is evidently to the interest of all these companies, which, with the parent company, are in masterful possession of the field, to work together, strengthening and consolidating their influence and position in every way, and where the advantages of co-operative combination are so self-evident, one need not be surprised at the steady maintaining of the *entente cordiale*. Just at the present time the suit of the United States Government against the American Bell Telephone Company is assuming a more definite aspect, but I really do not think that this will trouble the Minneapolis delegates very much. In connection with the Government suit, the claims of Daniel Drawbaugh of the invention of the telephone have lately been revived, on the ground that the blacksmith of Eberly Mills has new evidence to offer of a strong character. It is stated that a paper has been filed in the Patent Office by which the People's Telephone Company has assigned all its rights and title to some sixty Drawbaugh patents and applications for patents to three mutual trustees, Messrs. F. W. Jones, J. R. Bartlett, and H. C. Andrews. These three men have been connected with the Drawbaugh interest for some time, and have gathered all the material into their own hands for the purposes of another fight.

It may be mentioned here that the total valuation put upon electrical industries in this country at the present time is about $600,000,000, nearly all of which, save about $100,000,000 from the telegraphs, is the creation of the last ten or fifteen years. The amount invested in the telephone since 1876 approximates another $100,000,000, leaving about $400,000,000 for electric light and power with miscellaneous industries and manufacturing companies, wiring concerns and the like. It seems that this is a conservative estimate, and we may look for the actual figures when the next census is taken, it being proposed to have a special electrical section for the collection of such statistics.

It seems to be the intention of Mr. George Westinghouse to conduct his electric light business not less aggressively in England than he does here, where something like two hundred local companies have sprung up at his call during the last two years. Mr. H. M. Byllesby, vice-president of the Westinghouse Electric Company, has left for England to build a factory in London, and it is stated here that the company propose to give employment to 1,000 men as soon as they are in operation. If this be so, it will doubtless be very interesting for some of your old-established English electric lighting firms and companies, but I dare say they will manage to hold their own so long as they show themselves abreast of the times. Probably, as has

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happened before, this new competition, instead of hurting anybody, will stimulate business in every direction and prove highly beneficial in the long run.

CORRESPONDENCE.

ON HYSTERESIS IN THE RELATION OF STRAIN TO STRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I would venture to draw Prof. Ewing's attention to the fact that the lagging of mechanical strain behind stress, even when the latter is kept well within the so-called limit of elasticity, has been already shown by Prof. G. Wiedemann for torsion and flexure (*Phil. Mag.*, Vol. IX., Jan. and Feb., 1880; *La Lumière Electrique*, Vol. VI., Nos. 2, 3, 4), and by myself for longitudinal traction ("The Influence of Stress and Strain," &c., *Phil. Trans.*, Part I., 1883). The metals examined by me were unannealed piano steel, iron, platinum, German silver, copper, platinum-silver, brass, zinc, silver, aluminium, tin, and lead.—Yours, &c., HERBERT TOMLINSON.

PROF. PERRY'S VOLTMETER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with considerable interest and amusement your description of Prof. Perry's latest voltmeter. Although priority claims are usually wholly uncalled for, it may interest Prof. Perry to learn that a precisely similar instrument was devised about three years since by my late colleague, Mr. Ram, and myself. Our voltmeter consisted of a thin and narrow strip of steel fixed at each end and twisted at the centre in the way you describe. Finding it required some forty amperes to work it, we concluded it was merely an ammeter in disguise; moreover, the power wasted was enormous, and the index never returned to zero. We thought it hopeless, and with the carelessness of youth allowed the most "vastly simple" voltmeter to escape. However, it has fallen into good hands, and Prof. Perry is still a comparatively young man.—Yours, &c.,

SYDNEY EVERSHED.

Woodfield-road, Harrow-road, London, Sept. 24, 1889.

THE TESTS OF THE BROOKS' UNDERGROUND SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of last week, through apparently a printer's error, the insulation of the telephone cable, laid on the Brooks' system at the works of Messrs. Johnson and Phillips, was stated to be 88 megohms per mile, instead of 614, as was shown to be the case.

The resistance of the galvanometer used = 12,500 ohms. The deflection through 1·24 megohms, the galvanometer being shunted with 10 ohms, = 37 divisions. Length of each wire tested = 140 yards.

Total length of lead tested = 140 × 7 yards; as all the seven wires were bunched together.

The deflection due to the current passing through the insulation of the whole line (= 980 yards) = 52 divisions.

$$\frac{\frac{G+S}{S} \times 37 \times 1{\cdot}24 \times \frac{980}{1760}}{52} = x.$$

Insulation resistance of each wire = 614 megohms per mile.

You will much oblige me by inserting this correction in your next issue.—Yours, &c. H. C. HALL.

Victoria Works, Charlton, September 25, 1889.

[This test was intended to represent the conditions of an electric light cable, and the seven wires were connected together at one end. Having found the insulation resistance of the whole cable as measured to be 88 megohms per mile, our correspondent wishes to multiply by the number of wires joined in parallel. It appears to us that this is not consistent with the intention of reproducing as far as possible the condition of an electric light cable.—ED. *E.*]

THE ELECTRIC LIGHT AT PADDINGTON—SPECIAL MEETING OF THE VESTRY.

A special meeting of the Vestry was held on Tuesday last to consider what action should be taken with respect to the introduction of the electric light into the parish. The Committee reported that they have held seven meetings, and have devoted considerable attention to the subject. With reference to Resolution 3 of the proposal of Mr. Mark H. Judge and Mr. Mills, the receipt of the Model Order has rendered further consideration unnecessary as regards a uniform basis on which proposals from companies should be made. They have examined the Model Order clause by clause, and recommended the insertion therein of certain protective clauses, and they believe that all requirements for the benefit of the public interests have been duly cared for; and that should the Vestry decide upon employing a private company to supply electric light, they can safely do so on basis of the terms laid down in such Model Order. Touching systems of supply of electric energy, it appears to be quite needless to offer an opinion. Major Marindin in his report expresses a general approval of five distinct systems of supply; and while experts are still at variance as to what may finally prove to be the best, the Vestry may well adopt any system of which Major Marindin has expressed his approval, as to wait until a perfect system has been discovered would delay for years the introduction of the electric light into Paddington. The Committee have applied to the following companies:—The Electricity Supply Corporation (Limited), Metropolitan Electric Supply Company (Limited), House-to-House Electric Light Supply Company (Limited), S. Morse (on behalf of a company to be hereafter named), Westminster Electric Supply Corporation (Limited), London Electric Supply Corporation (Limited), Kensington and Knightsbridge Electric Supply Company (Limited), for definite information as to the price at which they are prepared to supply energy, both for public and private lighting, on the terms laid down in the Model Order. As regards the best mode of public lighting by electricity, there seems little doubt that arc lamps are the most efficient and least expensive. Mr. Spagnoletti, Chief Electrician of the Great Western Railway, entertains no doubt on this point. The installation under his charge in Paddington supplies energy to 100 arc lamps of 3,000 nominal candle-power, and 4,000 incandescent lights. Mr. Spagnoletti calculates that the annual cost of the admirable system arranged by him is not greater than would be that of gas at 2s. 9d. per 1,000 feet. The actual cost of public lighting by arc lights is difficult to arrive at, there being an extraordinary difference in the opinions of experts as to the number required for effective street lighting. Professor Forbes calculates that the lights should be 80 yards apart, and that 21 arc lamps would be required for a mile of streets. Mr. Mackie, on the other hand, considers that 10 arc lamps per mile would be adequate. Mr. Slater stated that the Galway Docks are most efficiently lighted by electricity, the arc lights there being placed, say, 150 yards apart. At Eastbourne 16 arc lights are set up on about a mile of beach, the posts being only 25ft. high, which is considered by the secretary of the Electric Lighting Company there to be too low. The arrangements at Hastings are identical in all respects with those of Eastbourne. At Taunton the arc lights run for an average of eight hours, at a cost of £22. 10s. per light. Taking everything into consideration, it would appear advisable for the Vestry to entrust the work of electric lighting to a well-established company, and in view of the possibility of the Local Authority desiring to purchase at any future time the undertaking of any company in the parish, they consider that it should be a *sine quâ non* that the central station should be constructed, and the distributing mains laid, so as to form a complete installation for Paddington independent of all connection with other parishes. The continuous-current system, in conjunction with storage batteries, as supplied by the Chelsea Company, is considered preferable for private lighting.

There were two motions on the agenda, one by Mr. Judge to the effect that, inasmuch as the Committee has not seen its way to recommend the Vestry itself to undertake to supply electricity for lighting and other purposes in the borough, it is desirable that steps be now taken to secure it being done at an early date by a private enterprise under a Provisional Order approved by the Vestry as the Local Authority; and another by Mr. Minchin:—"That in the interest of the ratepayers, the Vestry do keep the supply of electric lighting for Paddington in its own hands, and in order that such work may be carried out, a capital of not exceeding £50,000 be raised on the security of the lighting rate."

Mr. MINCHIN said that this was one of the most important questions ever brought before the Vestry. One year's delay had already taken place, and it was still in the power of the Vestry, by applying to the Board of Trade, to obtain leave to carry out the electric

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lighting themselves. He had the two reports. He accepted Prof. Forbes' report, more especially the reasons and suggestions he has given to the Vestry, to do the electric lighting themselves. Mr. Mackie's report was much less ostentatious, but much more practical, and if accepted it could be worked upon. Mr. Mackie was of opinion that £50,000 would be sufficient for these purposes, and if the Vestry agree to his proposal, Mr. Mackie would submit proper estimates in three weeks, which would be all that the Board of Works would require, and the Vestry would get their Provisional Order. St. Pancras had already got such an Order. He hoped Mr. Judge would not strive for a mere waste of time by moving to refer back. Everything was before the Vestry now, and it was the duty of the Vestry to vote on the motion at once. One hundred arc lights would light seven miles of streets, and he suggested Westbourne-grove and Harrow-road first, as the best streets, also Eastbourne-terrace, Westbourne-terrace, and from Royal Oak to Lock Hospital, and from Porchester-street to Westbourne-grove. The 20,000 incandescent lights and 100 arc lights he proposed would cost annually about £17,000, including everything, interest and depreciation of stock, &c. Mr. Minchin had no hesitation in saying that public lighting was impossible if handed over to the companies, their charges being actually prohibitive, and he asked the Vestry as a public duty to take it up themselves. If the Vestry took it up he maintained that in a few years the whole of the streets of Paddington would be lighted with electricity from the profit to be derived from the sale of energy. He agreed that the electric light was a luxury, and he agreed that it would not be right to charge the ratepayers with a high rate for such a luxury, but what he proposed would militate against this. The £50,000 could be raised on loan, and would cost the parish only ½d. rate further on the lighting rate. This would give the electric light under his scheme. He asked them to rise to the heights of the present opportunities. A company would take at least a year before completing, whereas the Vestry could get a Provisional Order before December, and in six months have the light going. Mr. Minchin then moved the motion standing in his name.

Mr. JUDGE said he would not introduce details or the merits of the various professional men whose opinions had been quoted. He proposed to add to his amendment to the effect that the Local Authority, if it desires, be able to purchase the concern at a term of 21, 31, or 42 years. In his opinion, if the Vestry wanted to get the best out of any work it must have private enterprise. The Vestry has all the chances of success and avoids those of failure if it retains to itself the power of purchase at the expiration of a number of years. He advocated two separate systems. If one went wrong the other could be depended upon. He should advise the Vestry to get a definite specification and let the firms estimate for that with sealed tenders, and not have some firms represented before the Committee by an expert. Mr. Judge then moved his motion as an amendment.

Mr. Judge having, at the request of the Vestry, previously withdrawn all the words after "Local Authority," thus leaving the length of time at which the Vestry should have power to purchase open, his amendment was put to the Vestry, when there were 24 to support and 6 against, Mr. Minchin's proposal being lost.

The special meeting then adjourned to Thursday, the 3rd of October.

"THE DANGERS OF ELECTRICITY."

The following letter from Mr. W. H. Preece appeared in the *Times* of Tuesday :—

"SIR : I have read a great many wonderful criticisms of what I am supposed to have said at Newcastle on the dangers of electric currents, but I have not yet read one on what I really did say.* I certainly did not say that alternate currents of high pressure were not dangerous to life, nor that wires conveying such currents may be handled with perfect safety, nor that deaths due to shocks received from electric light wires have been found on investigation to be nonsense ; what I did characterise as absolute nonsense was the reason a mining engineer adduced against using electric currents for the transmission of power in mines—viz., that a man who touched such a wire would be killed. Such currents are invariably direct currents of low pressure, and are therefore quite safe.

I also questioned the propriety of employing electricity for executing criminals, and I intended, as the writer of your admirable summary of the work of the British Association said, to throw 'grave doubts on the invariable certainty of death even from a powerful discharge of electricity.' In fact, no one can yet determine the current which will infallibly kill a man without torture.

I also referred to the propensity of newspaper correspondents to rush into conclusions at once that electric light currents were the sole cause of death, by adducing, amongst others, the Brighton case, where grave doubts as to the cause of death exist—doubts that are amply confirmed by Dr. Whittington-Lowe's letter, published by you on the 19th inst. It was a mistake to couple Major Cardew's name with the conclusion arrived at as to the stoppage of the current. The information on which I spoke was given to me by the local manager of the Electric Light Company.

I have already received a shock of 2,000 volts, and one of even greater voltage, for once I accidentally discharged a Leyden jar through my body, and I have not the slightest desire to repeat the experiment. I am far from underrating the dangers of electric currents, and it is surprising that some of my critics should think otherwise, when they know the active part I have taken in preparing rules and regulations for protection from fire and to person. In fact, I have acted as Chairman of three committees dealing with those questions.

The principal object of my remarks upon alternate currents was to emphasise the advisability of employing safety devices, such as the one described by Mr. Killingworth Hedges, which was the object under discussion. The result of experience is conclusive that electricity with proper precautions can be made safe, both from fire and death.

Every accident due to electric light wires, unfortunately too numerous, with which I am acquainted has been traced to stupidity, ignorance, or carelessness, sources of danger much more prevalent with gas and steam than with electricity, and every one remediable and provided against in regulations extant, but neglected.

It cannot be too strongly urged that the great sources of danger in electric light wires are bad material, inexperienced workmen, neglect of rules, and imperfect inspection. Cheap work in electric light equipments is not only nasty, but very dangerous."

*[What Mr. Preece "really did say" may be found in our report of the discussion on Mr. Killingworth Hedges' Paper in another column of this issue.—ED. *E.*]

BOOKS, &c., RECEIVED.

Prospectus of University College, London, for the Session 1889-90.

"Electricity in our Homes and Workshops." By Sydney F. Walker. (London : Whittaker and Co.)

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

September 16, 1889.

14,551. H. A. HENDERSON. Manchester. A primary battery solution.

14,552. H. A. HENDERSON. Manchester. Improvements in or relating to primary batteries.

14,565. G. DRAPER and W. H. ASH. London. Improvements in the method of and apparatus for recording telegraphic or other signs, more especially applicable to syphon recorder telegraphic instruments.

14,571. A. P. LUNDBERG. London. Improvements in electrical switches.

14,589. F. H. W. HIGGINS. London. Improvements in printing telegraphs.

14,590. H. GROVES and J. H. STEWART. London. Improvements in electric bells.

September 17, 1889.

14,593. H. F. CAMPBELL. London. Improvements in metallic circuits or conductors of electrical energy.

14,601. G. MACAULAY-CRUIKSHANK. Glasgow. An improved connector for the elements of electric batteries (S. H. Barrett, Massachusetts).

14,636. G. FLETCHER. Derby. Improvements in apparatus for the automatic control and regulation of electrical currents for electric lighting and other purposes.

14,649. W. R. LAKE. London. An improved covering for steam pipes, electrical wires, and the like (C. T. Lee, United States).

14,656. A. BERNSTEIN. London. Improvements in electric glow lamps.

14,666. J. W. RENO. London. Improvements in electric conduits for street railways.

14,677. R. R. MOFFATT. London. Improvements relating to the application and utilisation of electro-magnetism for the separation of metals and to the apparatus therefor.

September 18, 1889.

14,684. H. P. NICHOLAS. Beckenham. Electrical advertisement moving machine.

14,711. T. G. TAGG. London. Improvements in the equipment of craft driven by electricity or any agency other than fluid pressure.

September 19, 1889.

14,780. G. TOYE. Hendon. Improvements in the construction of body batteries for curative purposes.

14,783. W. MEISSNER. London. Distribution of the electric current and the current absorbers in installations with multiple conductors.

SPECIFICATIONS PUBLISHED.

1888.

12,264. ELMORE and ELMORE. Preparing metallic surfaces for electro deposits. (Price 6d.)

12,856. ZIPERNOWSKY and DERI. Converting electrical currents. (Price 8d.)

15,626. SCHOOP. Electric batteries. (Price 8d.)

16,141. TYER. Electric contact apparatus. (Price 8d.)

16,339. LANGDON-DAVIES. Generating rythmic electric currents. (Price 8d.)

1889.

10,814. KEEN. Lanterns for electric lamps, &c. (Price 8d.)

11,075. CURRIE. Dynamo electric machines. (Price 8d.)

Amended Specification.

747*, 1887. WYNNE. Applying electricity to propel vehicles on roads. (Price 8d.)

Second Edition.

9,728, 1887. THOMPSON (Westinghouse). Electric converters, &c. (Price 8d.)

The Direct Spanish Telegraph Company.

The following is the report and accounts of the Directors of this Company for the half-year ended June 30th last, to be presented at the general meeting of shareholders to be held on Tuesday, October 1st, at Winchester House, 50, Old Broad-street, E.C., at one o'clock :—

1. The accounts for the half-year ended June 30th, 1889, show, after providing for debenture interest, a balance to the credit of profit and loss of £5,300. 0s. 7d.

2. The traffic receipts are in excess of those for any half-year since the formation of the Company, and show an increase of £508. 6s. 10d., as compared with the corresponding half-year of 1888.

3. The working expenses are £4. 16s. 4d. less than in the corresponding period of last year.

4. With the exception of the interruption of the Bilbao cable from the 11th to the 27th January, referred to in the last report of the Directors, the Company's cables and the land-lines in connection with them have continued in good working order. The cost of the repairs of the Bilbao cable have, as intimated in the same report, been paid, partly out of the reserve fund and partly out of revenue, in the following proportions :—£1,500 from the reserve fund, and the balance (£1,442. 9s. 2d.) out of revenue.

5. The Directors have put £2,500 of the balance of profit and loss to the reserve fund, which now amounts to £14,837. 19s. 10d., and there remains an available balance of £2,800. 0s. 7d. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 5 per cent. per annum (free of income-tax) on the ordinary shares, carrying forward £44. 8s. 7d. to next account. The dividend warrants will be issued on October 1st.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended September 13, 1889, amounted to £2,270, and for the week ended September 20, to £3,170.

CHAS. MACINTOSH AND COMPANY (LIMITED).—This company was registered on the 12th inst. with a capital of £300,000, in 2,000 preference and 4,000 ordinary £50 shares, to acquire the goodwill of the business of india-rubber manufacturers, merchants, and commission agents, and other businesses auxiliary thereto, carried on under the style of "Charles Macintosh and Company," at Manchester, London, Liverpool, and Glasgow. Registered office, Cambridge-street Works, Chorlton-upon-Medlock, Manchester.

EASTERN EXTENSION TELEGRAPH COMPANY.—A dividend of 2s. 6d. per share for the quarter ended June 30 last has been declared by the Eastern Extension, Australasia and China Telegraph Company (Limited), payable on the 15th proximo ; and after charging £50,000 against revenue on account of the Western Australian cable, a balance of £26,236 will remain to be carried forward.

REUTER'S TELEGRAM COMPANY (LIMITED).—At a board meeting held on Wednesday, the directors of this company declared an interim dividend at the rate of 5 per cent. per annum, free of income-tax, for the half-year ended the 30th June last, payable on the 12th proximo.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 13, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £1,128, and for the week ended September 20, £2,071.

BUSINESS CHANGES.—Mr. E. L. Joseph has resigned his position with Mr. Julius Sax, and has joined the firm of Messrs. Appleton, Burbey and Williamson, as traveller.

CHANGE OF ADDRESS.—The offices of the Montevideo Gas Company (Limited), have been removed from 103, Gresham House, Old Broad-street, E.C., to Suffolk House, Laurence Pountney Hill Cannon-street, London, E.C.

NEW VALVE

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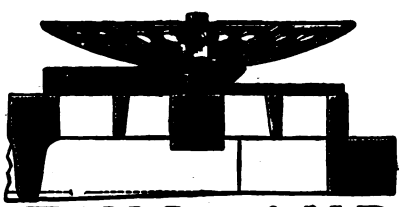

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Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature. Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

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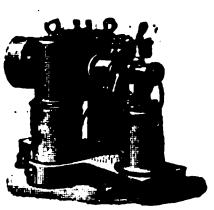
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Sept. 25, 1889.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Sept. 25, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	15/0	Anglo-American	52½ 53½	4 13 6	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	30/0	Do. Preferred	89½ 90½	5 10 6	,, ,,	90¾	89⅝
2,614,820	Stock	...	Do. Deferred	17½ 18¼	...	February	18½	18⅛
130,000	£10	5/0	Brazilian Submarine	13¾ 14	5 14 4	Mar., June, Oct., Dec.	14 9/10	13⅝
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	107	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅝ 4	4 0 0	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10¾	5 16 2	Jan., Apr., July, Oct.	10¾	10½
380,000	10	5/6	Eastern	13⅝ 14	4 12 10	,, ,,	14	13⅝
70,000	10	3/0	Do. 6 per Cent. Preference	15½ 15⅝	3 16 2	,, ,,	15⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	110	109⅝
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅝ 13⅝	4 15 5	Jan., Apr., July, Oct.	13¾	13 7/8
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	103½	102¼
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	4/0	Globe Telegraph and Trust	8⅛ 8⅝	8 7 3	Jan., Apr., July, Oct.	8 1/8	8 1/8
178,992	10	3/0	Do. 6 per Cent. Preference	14¼ 15⅛	3 19 4	,, ,,	15⅛	15
150,000	10	5/0	Great Northern	15½ 15⅝	4 15 3	Jan., July, and April	15½	15½
17,000	25	37/6	Indo-European	40 42	6 1 6	April and October	...	...
9,000	8	8/0	Reuter's	6⅝ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	9 1/8	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
30,000	10	5/0	West Coast of America	10½ 10¾	5 2 4	January and July	10⅝	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	2⅝	2¼
84,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12⅛	12
4,669	10	*	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	...	...
45,181	15	9/0	Western Brazilian	10⅝ 11¼	6 10 4	March & September	11⅛	10⅞
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,350	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 4	...	...	...
55,000	5	...	United River Plate	5 5⅛	...	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	3½ 4	...	...	3⅜	...
23,692	5	2/0	Do. (fully paid)	4½ 5	...	February & August	4⅜	...
79,934	5	...	Swan United (£3. 10s. paid)	4½ 5	...	...	4⅜	4⅜
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	45¾	44¾
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19¾	19

* No dividend since May, 1880.



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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 594.—Vol. XXIII. FRIDAY, OCTOBER 4, 1889. Price Fourpence.

NOTES.

In another column will be found the list of awards to the English firms who exhibited at the Paris Exhibition in Class 62 (Electricity). Considering that the exhibitors only numbered 18, it is very creditable that no less than 14 awards were made. This is a slightly higher average than that attained by the 291 French electrical firms, who between them obtained 210 awards, including 6 grand prizes; and it is a much higher average than that attained by the 33 American exhibitors, who were granted 19 awards, including no less than 4 grand prizes. The Silver Medal awarded to the Electrical Power Storage Company was for the E.P.S. system of public supply of electricity devised by Mr. King, and now at work in Chelsea. Woodhouse and Rawson United (Limited), who did not exhibit in the British Section, were granted a bronze medal for the exhibits of their French branch.

The announcement that the London Electric Supply Corporation had commenced lighting operations on a practical scale from their Deptford station on Tuesday last is, we learn, premature. Nothing has up to the present been done from Deptford, beyond a little experimental lighting at the offices of the Corporation at Adelphi-terrace. In the course of a few days, however, the Grosvenor Gallery station will be relieved of a large portion of its load, though, until the mains which are being specially made for the Corporation are completed, it is not deemed advisable to exceed a pressure of 5,000 volts. It is this, no doubt, which gave rise to the rumour that the Corporation intended permanently to reduce the primary potential from 10,000 to 5,000 volts, which, as we stated some time since, is not the case. Considering how much depends on the success of the Deptford scheme, we are not at all sorry to see that the London Electric Supply Corporation have no intention of starting work until everything is really ready.

The Metropolitan Company has for some days been supplying current to the Gaiety Theatre from its station in Sardinia-street. This company, it will be remembered, has also for some time been supplying current to the Garrick Theatre.

The visit of Edison to this country, combined with the greater visibility of the operations of the metropolitan electric lighting companies and the approach of winter, have induced the daily press to devote a considerable amount of its space to electric lighting matters, with the natural result that the public has been regaled with some facts and much fiction. One satisfactory feature of this revival of interest in electric lighting is the rise in the price of the shares of the leading supply companies. Both Brush and Edison-Swan shares have, we are glad to see, participated in this upward movement.

In another column we reprint from the *Journal* of the Society of Arts the practical directions recently given by Mr. Vernon Boys for mounting needles, or mirrors, &c., with quartz fibres. Seeing that the fibre itself is so small as to be invisible, the operation is naturally one which requires some little dexterity, but the method described by Mr. Boys leaves one under the impression that, on the whole, it must be a less difficult and a much less tedious process than that of mounting a cocoon fibre. The immense superiority of the quartz thread is now so well understood that it would be waste of time to recapitulate its advantages in detail, and now that the method of manipulating the fibres has been made clear we may expect a general sweeping away of cocoon threads from our physical laboratories. This step will be rendered the easier by the fact that Mr. Boys has generously refrained from patenting his very beautiful discovery. We understand that one at least of the best-known instrument makers is now supplying apparatus with quartz suspension on demand.

Our New York correspondent sends us some account of an alternate-current motor devised by Lieut. Patten. This machine is identical in principle with the synchronous motor designed at a comparatively early date by Mr. Mordey, and of which some description appeared in our issue of August 9th last. In the Patten motor, however, the two-part commutator of the Mordey machine is not employed, the synchronous reversals of the current in the field-magnet coils being effected by an ingenious method of coupling the armature coils to the commutator. The device can scarcely be made clear without a diagram, which we hope to give next week. This motor must necessarily possess the defects of its type; a commutated alternate current is by no means the equivalent of a continuous current.

The network of inter-urban Telephone lines which has recently been opened by the Postal Telegraph Department in South Wales naturally gives rise to pathetic complaints on the part

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of the Western Counties and South Wales Telephone Company and their shareholders. This company has laid out a lot of capital in long-distance lines, and although the convenience of immediate communication between Bristol and the South Wales towns is very great, we believe the Company is only now beginning to reap the benefit. We scarcely anticipate, however, that the immediate effect of the Post Office competition will be very severely felt, since the service offered by the latter, though excellent in itself, is much more restricted as to area of communication than that of the Company. On the other hand the Telephone Company makes itself a little ridiculous by assuming a martyr-like air. To hand over 10 per cent. of your gross receipts to your trade rivals is, doubtless, galling; but then it is an old story by this time, and we cannot feel much sympathy with the reiterated complaints which arise wherever the Post Office choose to exercise its uncontested powers.

THE chief importance of the incident, we take it, is as an indication that the POSTMASTER-GENERAL is not wholly oblivious of the fact that by judicious extensions of the existing Postal system it should be possible by-and-bye to reduce somewhat the financial magnitude of the transactions by which the Companies will be ultimately extinguished. It is probably, however, in the North of England, rather than in the West, that such extensions may be looked for. Meanwhile, the simple fact that all Post Office extensions have to be paid for out of revenue, and that the Telegraph revenue is not over-prosperous, may serve to spare the shareholders from undue alarm.

IN connection with our recent visit to the Bradford Central Station, to which we made some allusion last week, a singular thing has since occurred. Mr. SHOOLBRED—at whose invitation we made the journey and who received us with every possible courtesy—was at the time made fully aware of the arrangements we had in view for giving a detailed description of the installation and for illustrating some of its special features. To this he raised no objection whatever, nor is it easy to see what reasonable objection could have been raised. Nevertheless on Monday last we received from Bradford the following communication (to which it will be observed no signature is attached):—

TO THE EDITOR OF THE ELECTRICIAN.

"SIR,—With reference to your recent visit here, we regret very much to have to inform you that Mr. Shoolbred objects to any information or sketch being given other than that which he himself has already supplied.—Yours, &c.,

BRADFORD CORPORATION ELECTRICAL WORKS.

Electric Light Station, Bolton-road, Bradford,
September 28th, 1889."

Now, although in this particular case the matter cannot be regarded very seriously one way or the other, yet we are nevertheless compelled to enter the most emphatic protest against what at least appears to be Mr. SHOOLBRED'S ideas on the duties and privileges of technical journalism. It was open to Mr. SHOOLBRED not to have invited us to visit the station at all; it was also open to him to have requested us to keep silence on any point of detail in which patent rights or other equally cogent reasons might be concerned—that is always well understood—but it is certainly not open to Mr. SHOOLBRED or anyone else, without laying themselves open to possible misconstruction, after having invited a journalist to inspect his work, to object at a subsequent date, and without reason given, to the publication of any other account "than that which he himself has already supplied." It is, of course, a very common thing to receive descriptions of apparatus, or installations, from the makers or contractors, and in inserting such communications it is always made clear that they bear no editorial endorsement, but this is the first occasion within our experience where we have been asked to come and look at a thing and then told, "Now this is what you must say about it, and we object to your saying anything else."

THE City Commissioners of Sewers have met again, and at last their thirst for information has been slaked by a successful motion for the printing of the report of the Streets Committee. Mr. ROSE-INNES was even anxious to have full information with regard to the electric lighting of the City in 1881; but this proposal met with no support. The electric lighting question having thus made some slight progress, the Commissioners immediately adjourned.

THE fact that Mr. GISBERT KAPP has resigned the position of London Editor of *Industries*—which he has filled with conspicuous ability and success since the foundation of that journal some three years since—must necessarily be a matter for regret amongst its wide circle of readers. Mr. KAPP'S retirement has been brought about by the increasing demands upon his time in his capacity as consulting electrical engineer, to which work he intends in future to devote his whole attention. We cannot but feel it to be a matter for congratulation that at a time when there is so much practical work to be done, and so few really qualified men available, an engineer who combines in a peculiar degree theoretical knowledge with practical skill and experience should devote his whole energies to the consulting branch of the profession. Mr. KAPP is succeeded at the office of *Industries*, to a certain extent, at least, by Mr. SWINBURNE, who, we understand, will hold the position of "Electrical Editor"—our readers will agree with us that a better choice could not possibly have been made. Hitherto, however, our contemporary has not devoted a great deal of attention to electrical matters, and we understand that this appointment will not in any way interfere with Mr. SWINBURNE'S existing arrangements.

Electric Lighting in Australia.—Steps are being taken both at Newcastle (New South Wales) and Fitzroy (Victoria) to have the streets lighted by electricity.

Mr. Edison in London.—The name of Mr. J. E. H. Gordon should have been included amongst those present at the dinner given by Sir John Pender last week in honour of Mr. Edison.

Worcester.—At a meeting of the City Council on Tuesday last it was resolved that the Council should apply to the Board of Trade for a Provisional Order authorising them to supply electricity in Worcester.

Blackpool.—The Blackpool Town Council resolved last week that an application should be made for a Provisional Order authorising the Corporation to supply electricity for any public and private purposes in the borough.

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Waterford.—At the last meeting of the Town Council it was decided to appoint a Special Committee to take the necessary steps to obtain an electric-lighting license, and to oppose the applications from private firms.

Edinburgh.—The Works Committee of the Edinburgh and Leith Gas Commissioners have resolved to recommend the Commissioners to refuse their consent to any of the electric lighting companies obtaining Provisional Orders.

Dundee.—The Special Committee of the Dundee Gas Commission at their last meeting were unanimously of opinion that the Commissioners should acquire power to supply the electric light. A report to this effect will be presented at the next meeting of the Commission.

Leicester.—A special meeting of the Town Council will be held on the 29th inst. to confirm the proceedings of the meeting held on August 27th, when the report of the Gas Committee, recommending that the Corporation should apply for an electric lighting Order, was unanimously agreed to.

Cardiff.—At a meeting of the Electric Lighting Committee of the Cardiff Corporation, held on Monday last, it was resolved that the Council should be recommended to oppose the whole of the applications to be made by the several electric lighting companies for Provisional Orders.

Society of Engineers.—On the 1st inst. a visit was paid by the Society of Engineers to the Central Station of the London Electric Supply Corporation, at Deptford. The company were received and entertained at luncheon by the directors, and were afterwards conducted over the works by Mr. Ferranti.

Aberdeen.—At a meeting of the Gas Committee of the Aberdeen Town Council, held last week, it was agreed to recommend that at the special meeting of the Council to be held on the 7th, to consider the advisability of applying for powers for the lighting of the city by electricity, exclusive powers should be asked for by the Town Council.

Wolverhampton.—At a special meeting of the Town Council to be held on the 31st, the notices of the Wolverhampton Electric Light and Power Company, and the Midland House-to-House Electricity Company, will be considered, and the question of the Corporation undertaking the electric lighting will be discussed.

The Edinburgh Exhibition.—It is announced that the Queen has given her patronage to the Exhibition, and among those who have already agreed to act as patrons may be mentioned the Duke of Buccleuch, the Duke of Sutherland, the Earl of Aberdeen, the Earl of Rosebery, the Earl of Elgin, and the Earl of Kinnoull.

Telephonic and Telegraphic Development in Russia.—According to a correspondent of *The Times*, 500 versts (1 verst = $\frac{2}{3}$ mile) of telephone lines are to be established shortly in European Russia and 100 in Asiatic Russia. To the existing telegraph net there are to be added shortly 1,588 versts in European Russia and 1,421 in Asiatic Russia.

Sale by Tender.—Messrs. Beal, Son and Chartres announce the sale by tender of the lease of the premises at Golden-square, for many years in the occupation of the late Sir Charles Bright, together with the electrical and other instruments, tools, models, &c., and office furniture and effects. Further particulars are given in our advertisement pages. Tenders must be sent in by twelve o'clock on Wednesday, October 16.

Sale by Auction.—Messrs. Wheatley Kirk, Price and Goulty will sell by auction on Tuesday, Wednesday, Thursday and Friday, October 15, 16, 17 and 18, the contents of the works of Messrs. Appleby Brothers, Limited (in liquidation), situate at East Greenwich. Some high-class engines, boilers, machine tools, &c., &c., are included in the sale, further particulars of which will be found in our advertisement columns.

Terni.—The electric lighting of the large steel works at Terni, of which the superficial area is upwards of 2,000,000 square feet, is effected by 100 2,000 candle-power arc lamps and 1,200 75 candle-power incandescent lamps. The current for the arc lamps is supplied by twelve 10 horse-power dynamos driven in pairs by 20 horse-power turbines, the incandescent lamps being supplied by two 75 horse-power dynamos, driven by a 150 horse-power turbine.

Walsall.—At a special meeting of the Walsall Town Council on Monday last week, the Mayor moved the adoption of a recommendation of the Electric Lighting Sub-Committee to the effect that the right to supply electricity should be vested in the Council, and that the Council should make application for a Provisional Order empowering them to supply electricity for public and private purposes within the borough. The recommendation was unanimously agreed to.

The Van Rysselberghe System in Bavaria.—According to the *Centralblatt für Elektrotechnik*, the postal telegraph authorities in Bavaria have declared that the defects in the inter-urban lines established on the Van Rysselberghe system cannot be attributed to the telegraphic apparatus used, but are due to the nature of the system itself. The introduction of the Van Rysselberghe system was, however, vehemently opposed from the beginning by the Government electricians.

Club Lighting.—The new Prince's Club, at Knightsbridge, was lighted by electricity for the first time about a fortnight ago, and the lighting has been pronounced to be a great success. The United Electrical Engineering Company have carried out the work according to the plans of Mr. A. H. Vesey, and the Committee of the Club have requested Mr. Vesey to light the tennis and racquet courts in such a manner that no shadow will be thrown upon the ball during play.

Electrical Engineering Appointments.—Mr. James Raeburn has just been appointed electrician to the Thomson-Houston Company, at Hamburg. Mr. Herbert E. Sturr has also been appointed to the Central Electric Lighting Station at Exeter, and Mr. Arnot has gone to Melbourne to fit up an electric tramway and represent a well-known electrical engineering firm. These gentlemen were all students of the Glasgow and West of Scotland Technical College electrical engineering classes.

Telephonic Development in the West of England.—Steady progress is being made in Torquay and the neighbourhood in the matter of telephonic communication. The number of subscribers to the Torquay Exchange has now reached about 140, and the average daily calls are between 400 and 500. Increasing use is also being made of the telephone in the surrounding towns. Torquay and Plymouth have recently been placed in telephonic communication, and the line is much used.

Obituary.—Mr. C. H. Sharples died suddenly at his residence, Preston, on Sunday, 22nd ult. Mr. Sharples was the junior member of the firm of Sharples and Son, electrical engineers, Fishergate, Preston. He was a Fellow of the Chemical Society and a member of the Institution of Electrical Engineers. He was the first to introduce the telephone into Preston by the establishment of the Preston Telephonic Exchange Company, which, after a few years' existence, was taken over by the Lancashire and Yorkshire Telephone Company.

Calcutta.—We understand, says *Indian Engineering*, that the Government is desirous of introducing the electric light in the Viceregal residence in Calcutta and also in the Lieutenant-Governor's residence, Belvedere, and that several firms have submitted estimates for the work, all of which have proved rather higher than anticipated. The difficulty from the electrical engineer's point of view is that plant and appliances for a full system of lighting have to be provided, although the light is required for only a few months of the year.

Exeter.—The motion for cancelling the permission recently given to the Exeter Electric Light Company to erect overhead wires was rejected at the last meeting of the Town Council by 11 to 25 votes. The Exeter Electric Light Company have successfully installed the electric light at Exeter New Theatre Royal, the installation comprising 450 Edison-Swan lamps of 16-candle power. Over 1,000 lamps have been ordered for private houses, shops, hotels, and public institutions at Exeter, and the company will complete their station next month.

Prize Offered by the Darmstadt Technical College.—The Council of the Darmstadt Technical College have propounded the following question, answers to which will be received up to May 1st, 1890:—The losses which take place in alternate-current transformers consequent upon the heating of the iron are due partly to Foucault currents and partly to molecular friction caused by the changes of magnetism. The influence of each of

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these two causes on the total loss under various conditions must be determined by experiment. A prize of 150 marks is to be awarded.

Leeds.—The Leeds Borough and County Council decided on Wednesday, after a brief discussion, to postpone the further consideration of the report of the Electric Lighting Committee for six months. As the municipal year closes in November, this decision is equivalent to postponing the subject indefinitely, and the adoption of the amendment to this effect by 28 votes to 17 was practically the abandonment of the scheme, which was presented to the Council on July 3rd, and involved an estimated total capital expenditure of £68,000. (*Electrician*, June 28, p. 189.)

Glasgow.—The draft Provisional Order which it is intended to submit to the Board of Trade, asking powers for the Corporation to supply the electric light in Glasgow, will shortly be laid before the Corporation Gas Committee and the Corporation as a whole. Authority has been given to a special sub-committee to meet and confer with Messrs. Muir, Mavor and Coulson, or any other private firm who may desire to have a conference in view of the Provisional Order being applied for. It is thought that the actual work of generation and distribution will be let out on contract to one or more private firms.

The School of Electrical Engineering and Submarine Telegraphy.—We are informed that, as the result of the examinations for the certificate of the school, recently conducted by Mr. Gisbert Kapp, the following gentlemen have obtained the Certificate in Electric Lighting and Power Transmission :—Messrs. H. E. Bartlett, S. Bone, J. H. Bonwer, jun., J. A. Fraser, W. C. Goodchild. The candidates had to answer two Papers—one in Mechanical and the other in Electrical Engineering—and had also to pass a *viva voce* and practical examination. The minimum required in each Paper was 60 per cent., and for the practical examination 70 per cent.

Cheltenham.—A special meeting of the Cheltenham Town Council is to be held on the 21st to consider whether application shall be made to the Board of Trade for a Provisional Order authorising the Corporation to supply electricity for public and private purposes within the borough. Several electric lighting companies have sent in requests for the consent of the Corporation to the granting of Provisional Orders to them. The Town Council has, it will be remembered, already on more than one occasion decided that the introduction of the electric light was desirable, and that the introduction should be made by the Corporation rather than by a company.

A Large Belt Press.—A few years ago a 36in. or 40in. belt was as large as belt manufacturers were ever called upon to make, but with the growth of the manufacturing industries and the largely-increased size of single establishments, greater power is required than formerly, and belts of greater weight and width are constantly called for. To meet this new demand Fayrer-neath and Ladew, of New York, the manufacturers of the Hoyt leather belting, are erecting a hydraulic press capable of making belts of any width up to 78in. This is said to be the largest belt press that has ever been made, and it will be used first on a 64in. belt which has been ordered from the above-mentioned firm.

Lectures on Dynamo Machines.—We have received the syllabus of the course of twelve practical lectures on dynamos, which will be delivered by Mr. W. B. Esson at the School of Electrical Engineering at Hanover-square. From this we gather that Mr. Esson intends to deal with this important subject in a thorough and comprehensive manner. The best form and material for magnets, the reaction of the armature upon the field-magnets, parasitic currents, methods of armature winding, dynamo testing, dynamo efficiency, self-induction, &c., &c., will all be fully touched upon. This course of lectures will, we are sure, prove of great value to all who wish to obtain sound practical information on the subject of dynamo design.

Postal Telegraph Revenue.—The revenue returns for the quarter ended September 30th continue, so far as relates to the telegraph service, to show a most satisfactory increase. Compared with the September quarter last year there has been an increase of no less than £55,000, and on a comparison of the years ending September, 1888, and September, 1889, the increase amounts to £190,000. The details for the four quarters of the two years are as follows :—

	Dec. 31.	Mar. 31.	June 30.	Sept. 30.	Total.
1888-9.....	£515,000...	£520,000...	£525,000...	£620,000...	£2,180,000
1887-8.....	£465,000...	£480,000...	£480,000...	£565,000...	£1,990,000
Increase ...	£50,000	£40,000	£45,000	£55,000	£190,000

Metallisation in a Vacuum.—The *Revue Internationale de l'Electricité* describes a curious phenomenon recently observed when experimenting with electric discharges *in vacuo*. In a glass tube, 3 centimetres in diameter, from which the air had been exhausted, and containing at either end a platinum or copper electrode, consisting of a wire bent at right angles to itself several times so as to form a series of squares, one within the other, a 30-centimetre spark was passed. The metal was volatilised, and was deposited on the negative pole, taking the shape of the electrode it had left. The image formed by the deposited metal was, however, turned round through an angle of 90deg.

The Great Western Electric Lighting Works.—The following is a copy of a letter which has been sent to the Electric Lighting Committee of the Paddington Vestry :—

"Dear Sir : In your recent report to the Paddington Vestry I observe that you speak of the Great Western Electric Lighting Works having been designed and arranged by Mr. Spagnoletti. I am directed to inform you that the whole of these works were designed and carried out throughout by Mr. J. E. H. Gordon, the Engineer to the Metropolitan Electric Supply Company (Limited) and to the Electric Construction Corporation (Limited). The works were not placed in Mr. Spagnoletti's charge until after they were purchased by the Great Western Railway Company, after more than a year's successful running, and after all difficulties had been overcome.—Yours faithfully, HENRY SINCLAIR."

Moulded Mica Insulators.—We have it on the authority of the *Commercial Advertiser* of New York that a new kind of insulator has just been put upon the market. The substance is known as "lehte," a composition made largely of mica. It has been widely used for the purpose of trolley-line insulators in electric street railways, and has given great satisfaction. In motors it has found a place in commutator brush yokes, which are made entirely of lehte, or of iron with lehte covering. A valuable quality in this insulator is the ease with which it is attached to metal. Used as an insulating covering, or moulded together with metal parts for connection, the union of lehte and metal is so perfect that they cannot be parted, nor is there any possibility of separation by expansion or contraction of metal in change of temperature. While it is not intended for high temperature, lehte bears the greatest cold without becoming brittle, and, being unaffected by weather, it is highly suitable for outside work.

St. Hilaire-du-Harcourt.—The remote town of St. Hilaire-du-Harcourt (Manche) possesses an interesting little electric light installation, which has been running since the beginning of May. The dynamo is situated four kilometres outside the town close to a stream called the Vauroux, the water from which is collected in three ponds and made to drive two 10 horse-power 5 metre water wheels, running at seven revolutions a minute. The dynamo is a 10-unit (600 volts and 17 amperes) Thury machine, running at 800 revolutions. This machine charges three sets of Gadot accumulators, arranged in series at sub-stations in the town. The municipal lighting comprises 80 lamps, which are automatically switched on and off by a clockwork device attached to the Jacquemier coulomb-meter registering the ampere-hours furnished to the accumulators. The price of a 10 candle-power light for private consumers is 5 centimes per lamp per hour. The conductors, which are run overhead, are of bare copper wire.

Sheffield.—At a special meeting of the Sheffield Town Council, held last week, the application of the Sheffield Telephone Exchange and Electric Light Company for the consent of the Corporation to an electric lighting license was considered. The Mayor stated that at a meeting of the Improvement Committee a resolution was carried recommending the Council to send the same answer to this application as was sent to the one from the Electric Construction and Maintenance Company, namely, that

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the Council will not give their consent to any license or Provisional Order being granted to the company for supplying electricity in Sheffield, on the ground that the Council might probably itself seek to obtain powers necessary for that purpose. The Mayor moved a resolution to this effect, remarking that it was not at present desirable to allow any company to get a footing in Sheffield, because in the course of a very short time they would have to take up the question themselves and deal with it. The resolution was agreed to unanimously.

Stafford.—The Gas Engineer, Mr. J. Ferguson Bell, has presented a lengthy report on the subject of electric lighting to the General Purposes and Gas Committees of the Stafford Corporation. Mr. Bell thinks that it would not be advisable to erect a central station unless there is a probability of a minimum of 2,000 16 candle-power lamps being required within the area of supply. He recommends the adoption of the alternate-current transformer system, and suggests that if the Corporation decide to do the lighting themselves, a start should be made with a 3,000-light plant, to cost, with buildings, mains, &c., £14,500. The charges are to be 7d. per Board of Trade unit, or 40s. per 16 candle-power lamp per annum. Coming to the question of profit, Mr. Bell estimates that if 1,200 lights are taken up at 40s. a light, and allowing for a maximum consumption of current equal to 2,000 hours per lamp per annum, the station would yield a net income of about £200 per annum; if 2,000 lights are taken up, the estimated profit upon the same basis is £1,565.

Electrical Figures drawn by Lightning.—At a recent meeting of the Académie des Sciences, M. Ch. V. Zenger showed two mirrors which had been injured by lightning, and presented some remarkable traces of the discharge. On the 9th of June last a villa at Zehrooice, near Prague, was struck by a fireball, which burst with a formidable noise, piercing the roof and ceilings. The floor of the concierge's lodge was lifted 52 centimetres, and a looking-glass hanging against the wall was struck. The gilt frame of the mirror was damaged in ten places, the gilding being volatilised and deposited on the face of the glass, while on the back the volatilisation of the quicksilver gave rise to most remarkable electrical figures, the appearance of which showed that there had been multiple and successive discharges, as indicated in recent lightning photographs. The second mirror, presented by M. Zenger, was merely a fragment, the mirror having been shivered by lightning in July last while hanging up in the room of the manager of some chemical works at Wolfsschlinge, near Aussig (Bohemia). The fragment was pierced in numerous places, each perforation presenting the appearance of a water spout of molten glass which had suddenly been solidified.

The Lighting of the City.—A special meeting of the Commissioners of Sewers was held on Tuesday last with reference to the subject of electric lighting.—Mr. Sly moved: "That the report of the Streets Committee of July 30th, on electric lighting, and the abstract of tenders be printed and circulated among the members of the Commission."—Mr. Pannell said he did not think it would be any advantage to go back to the original contracts under which the City was more or less efficiently and sufficiently lighted, unless they followed the whole history from that time up to the present. There were a number of reports founded on the efficacy or non-efficacy of electric lighting, but it would be no advantage to have all that before them. The motion was carried.—Mr. Innes said he had no desire to obstruct the electric light. He moved—"That the engineer be requested to supply the names of the companies who lighted the City experimentally some years since, the districts lighted, and the result of the experiments up to the present day. This was negatived.—Mr. Pannell then moved: "That the engineer and Mr. Preece be requested to amend the abstract of tenders so as to make it uniform with the conditions under which the various companies are now prepared to contract. They would then have each of the companies' proposals before them. This was agreed to, and the Commission adjourned.

Birmingham.—It will be remembered that the Birmingham City Council some little time ago passed a resolution withholding consent to the application of Messrs. Chamberlain and Hookham to the Board of Trade for a Provisional Order empowering them to supply electricity for public and private purposes if the larger area outside the central area of the city were insisted on, but authorising the General Purposes Committee to consent to the said Order if the amendments of the Corporation were accepted, subject to such modifications of detail as the Committee or the Board of Trade might deem proper. The General Purposes Committee reported at the last meeting of the Council that after considerable correspondence with the promoters and the Board of Trade on the subject, a new and revised Order was sent to the Town Clerk by the Board of Trade, confining the area to be supplied to that comprised in Schedule A (the central area) as desired by the Corporation, and accepting and adopting a large number of their amendments. The Committee being of opinion that the Corporation amendments not inserted by the Board of Trade were unimportant, they had no hesitation in giving their consent to the Order in its amended form, and accordingly authorised the Town Clerk to affix the Corporate seal thereto, believing that the interests of the Corporation had been protected as far as practicable.

Post Office Telephone Competition.—A notice has been issued by the Postmaster-General to the effect that:—"On and after the 1st October the telephone wires which have been provided by the Post Office between the following towns in South Wales may be used by the public on payment of a fee of 6d. for a conversation not exceeding three minutes: Cardiff, Barry Dock, Newport, Alexandra Dock, Pontypool, Talywain, Briton Ferry, Swansea. Any person joining the telephone exchange of the department in one of these towns can use the wires to the other towns from his own office. Other persons can do so on going to an office of the department where a silence-box has been provided. The local telephone wires in the above-mentioned towns may also be used by the public; the fee for a conversation of not more than three minutes within one and the same town being 3d. Under this arrangement a person whose office is not connected with the local telephone exchange can at any time hold telephonic communication with a person whose office is so connected, on going to one of the offices of the department where a silence-box has been provided for the purpose. The limit of three minutes may be exceeded on payment of 6d. or 3d., as the case may be, for each additional period of three minutes or less." It is also announced that the telephone wires which have been provided by the Post Office between Liverpool and Manchester may be used by the public on payment of the same fee as above.

Method of Taking Photographs of Lightning Flashes.—At a recent meeting of the English Photographic Club, Mr. W. Marriott was requested to draw up instructions for taking photographs of lightning. The following brief rules are offered:—1. The camera should be focussed during the daytime to some distant object and a mark made on the camera, so that at night it may be quickly adjusted when a storm is approaching. 2. A rapid rectilinear lens, with full aperture, should be used. 3. The camera should be directed to the part of the sky where the lightning is most likely to occur. 4. The camera should be firmly screwed to the tripod stand. 5. It may be necessary to tilt the camera slightly, especially if the lightning be mostly in the zenith. If this be done, a note should be made of the amount of inclination. 6. A portion of landscape, roof, chimney-pot, &c., should, if possible, be included on the plate. If this cannot be done, the top of the plate should be carefully marked before it is removed from the dark slide. 7. The exact time of each flash, the interval in seconds between the lightning and the thunder, and the point of the compass in which the flash appeared, should all be carefully recorded. 8. It is desirable that there should be only one flash upon each plate. 9. If circumstances permit, two cameras should be used—one fixed on the tripod stand and the other held in the hand—and two separate photographs obtained of the same flash. 10. It would be very interesting and valuable if two or more photographers could obtain pictures of the same flash from different points of view. By this means it might be possible to determine accurately the distance of the flash, and also its movements in the atmosphere.

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SKETCH OF THE ELECTRICAL PAPERS IN SECTION A

READ BEFORE THE BRITISH ASSOCIATION AT NEWCASTLE.

BY DR. OLIVER LODGE.

Not a brilliant meeting so far as mathematics and physics are concerned, the most important Papers communicated to Section A at Newcastle lie outside the range of electrical science, and hence our notice this year may be brief. The distinction between Electricity and the rest of Physics is an arbitrary and unsatisfactory one, and it may be permissible, even in an Electrical Journal, to mention that the communications most interesting to physicists were one on "The Extensibility of Liquid Films," by Lord Rayleigh, and one on "Boscovich's Theory," by Sir W. Thomson.

The first was full of acute observations, based partly on a view of Marengoni regarding the cause of the permanence of liquid films in certain cases and their evanescence in other cases, and for the first time some distinct notion of the reason of the steady existence of a soap-bubble—that long-standing puzzle to physicists, began to be formed in the minds of those present. The Paper marks a very distinct step in advance in our knowledge of the mechanics and structure of soap-films.

The other communication I have referred to, that on Boscovich's theory, might have been called the Mechanics of Crystallography, or Molecular Statics. It was a powerful and acute piece of pure mechanical reasoning, showing how a great number of the extraordinary behaviour of crystals, including some only recently discovered, and some which at first hearing seem quite incredible, can be accounted for by imagining the molecules built up according to a certain law of force between the parts, a force attractive at some distances, repulsive at others, and not specially contemplating or troubling about how the forces arise, nor of what the substance of the molecules is composed—treating them, in fact, as abstract centres of force (which they certainly are, however much else they also be) and ignoring their inertia, very much as Boscovich in his century-old memoir did. Crystals of various orders, hemihedral crystals, crystals with a periodic structure, and consequent curious selective reflexion for light, crystals that can be sheared, and molecules that are liable to fly to pieces and detonate, were all referred to, and models built up of spiral springs were used to illustrate them.

Taking now the Electrical Papers in order, we find first a preliminary account of a determination of "v," the velocity of electro-magnetic radiation, made by the writer and Mr. Glazebrook by means of the oscillating discharge of a Leyden jar. The method consists in taking an air-condenser of measurable capacity, discharging it across a pair of knobs through a circuit of measurable self-induction, and observing the rate of oscillation during the discharge by photographing the spark on a sensitive plate kept whirling at a known number of revolutions per second. The record on the plate is afterwards examined micrometrically, and the arc occupied by an electric oscillation accurately determined. In the final series of measurements the condenser was built of 11 plates of plate glass cut 2ft. square, silvered on both sides, and set up parallel to one another, with an air space of half a centimetre separating adjacent surfaces. The capacity of this condenser was about 60 metres in electrostatic measure. The discharge circuit consisted of about three miles of No. 22 india-rubber covered copper wire, carefully wound into a regular coil 11in. inside, 19in. outside diameter, and 4in. thick. The self-induction of the coil was $4\frac{1}{2}$ quadrants (or secohms) in electro-magnetic measure. The spark occurred between two small knobs, about a millimetre or so apart, and the charging was done by means of an ordinary Voss machine, half connected half disconnected by means of a needle-point arranged to give a brush discharge across an inch of air into one coating of the condenser; the other coating, consisting of the two outside and the other alternate plates, being earthed.

The photographic disk, on which the spark record was obtained by means of a quartz lens focussing the spark knobs upon it, was pivoted on an axis perpendicular to its plane and spun by means of a turbine (a Bailey "Thirlmere" water motor) 64 turns a second. The speed of the disc was measured and kept constant by the same device as that used by Lord Rayleigh in his classical determination of the ohm, viz., a stroboscopic card attached to the axis of the disc and watched between the jaws of a vibrating tuning-fork. The fork being set accurately to vibrate 256 times a second, a four-rayed star pattern on the card was kept optically stationary by the observer letting the driving string pass through his fingers and tightening or slackening his grip of it as required.

Under these circumstances the spark image on the plate is drawn out into a long-beaded band or circular arc, each bead of which corresponds to a semi-oscillation. With the dimensions above specified each bead occupied an arc of about 13deg., and there were 8 or 10 of them visible for each spark. In this way a record of about 30 sparks in eight concentric circles were obtained on each plate, and dozens of plates were filled. The plates were Messrs. Mawson and Swan's most highly sensitive, 4in. square, and were kindly sent for the purpose by Mr. J. W. Swan.

The calculations are not yet completed, but the value of "v" is coming out of the same order of magnitude as that obtained by other and simpler methods.

Prof. Ewing's Paper on "Magnetic Viscosity in Iron" has to do with the effects of very small magnetising forces applied for a long time. He finds that iron does not behave as a rigid body to these forces, but that there is a slow viscous yielding or development of magnetisation, which as slowly subsides when the force is withdrawn.

The magnetic behaviour of iron is therefore quite analogous to the mechanical behaviour of an elastic solid possessing a trace of plasticity, partly obeying variations of force instantaneously, and partly yielding continuously to a force kept steadily applied for a long time. Of course all this viscous yielding is accompanied by dissipation of energy and production of heat. The effect had been observed by Prof. Ewing before, but he now measures it carefully and goes into much detail regarding it.

On Monday were read a few Papers on "Atmospheric Electricity."

Prof. Michie Smith described the observations he had made in India with a Thomson portable electrometer, and related the manner in which he had succeeded in getting the instrument to work, notwithstanding the damp tropical heat. It was done by taking extra precaution about the drying acid inside, by charging with a machine instead of with the customary electrophorus, and by having the insulation of the charging rod too hot to touch. In fine weather, though the potential of the air was, as as usual, positive, he found a cloud of dust gave distinct negative indications. This observation was explained by Sir William Thomson, in the simplest manner, by the statement that in fine weather the upper regions of the atmosphere were positively electrified, and the earth's surface negative, while the potential of the air was everywhere positive, gradually increasing upward from zero at the earth surface to a high value. This being the normal state of things, a cloud of dust, or anything else blown from the surface of the earth, would naturally be found with a negative charge after the fashion of a proof-plane.

Prof. L. Weber sent some photographs of lightning taken in a camera moved elliptically by hand. This mode of motion scarcely gave so simple an analysis of the flashes as the simple lateral motion employed by Dr. Hoffert, but, just as in his case, some flashes were analysed into several intermittent discharges connected by a luminous glow or aureole of phosphorescent air. Flashes thus analysable are really a succession of rapid spits, such as can be obtained in the laboratory through a very high resistance, and they last an appreciable time. It is probable that they are not the sudden and violent kind of flash.

Mr. Clayden described again his experiments on obtaining dark flashes from a Wimshurst machine on photographic plates, and showed that these dark appearances were matters of photography and developing, and accordingly were of chemical not physical interest. In this statement he had the concurrence of the President (Captain Abney).

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A Paper by Messrs. Maclean and Makita Goto described some experiments on the electrification of air by ordinary combustion. It was found that burning charcoal electrified the air negatively, while burning phosphorus and most other things electrified it positively. It is to be supposed that the electrification observed belongs really to smoke particles and not to the air itself, since it is not likely that air itself can be charged, but the fact that some atmospheric electrification can be certainly produced by combustion may possibly have an important meteorological bearing.

Coming now to Tuesday, a considerable number of electrical Papers were rapidly gone through. The Electrical Standards Committee reported in favour of adopting Mr. Heaviside's term "impedance" for the ratio of an averaged electromotive force to an averaged current. *Spurious resistance* is the only other term that suggests itself, and it is a pity the French Congress did not decide on this in preference to "apparent resistance." "Fictive" is a term more correctly applicable than "apparent," for, as Lord Rayleigh said, the identity of impedance with resistance is only "apparent" if you shut your eyes. The term resistance will remain defined, in accordance with Joule's law, as the ratio of the energy dissipated per second to the mean square of current. The resistance thus defined is by no means independent of the effects of self-induction in the case of rapidly alternating currents. The choking or throttling of the conductor by concentration of current to the periphery forms part of this true resistance, but no mere inertia-like or massive obstruction without frictional dissipation is included in it. Every kind of obstruction is lumped together in the idea connoted by impedance; the term resistance is limited to frictional or irreversible obstruction. For steady or slowly-varying currents in homogeneous circuits the two coincide.

It may be helpful to remark that impedance and resistance of every kind are all quite properly expressible in ohms; hence the sometimes-employed term "ohmic resistance" is not really discriminative.

Most of the resolutions adopted by the Paris Congress could be re-adopted by the Standards Committee with satisfaction; but on one point there was some discussion, viz., with respect to the name for the unit coefficient of electro-magnetic induction. The rather barbarous name "secohm" has never been quite heartily received, though it is unobjectionable in every scientific respect; the name "quadrant" now adopted, although in the electro-magnetic system of units the quite natural and simple statement for a thing of the dimension of a length, and a length approximately equal to the Earth's quadrant, yet has the disadvantage of always entailing the appendage, on occasions when one wishes to be exact, of the words "in electro-magnetic measure."

Those who feel, like the writer, that the artificial electro-magnetic and electrostatic systems are both doomed to leisurely extinction in the course of the next few decades may experience some regret that a name so manifestly signifying a length should be thus introduced for a quantity which is not a length at all, and which is only the dimension of a length on a conventional system of units.

No such objection applies to the word "ohm" or its derivatives; for though it is sometimes asserted that an ohm is a velocity, by those who ignore the fact that it is only a velocity on a conventional system, yet nothing of the kind is connoted by the term; and the ohm as a practical unit of resistance may last for ever. However, so long as it be clearly recognised that the quadrant is merely the *electro-magnetic* unit of self-induction, and that not except thus conventionally is self-induction a length any more than resistance is a velocity, so long the term may be accepted as, perhaps, on the whole, the most convenient for temporary and terrestrial use.

Mr. Shaw communicated the first part of his report on Electrolysis, the gist of which mainly was that Ohm's law, Joule's law, and Faraday's law were the fundamental facts on which there seemed to be no legitimate difference of opinion, and which might be taken now as well established for many electrolytes, if not for all. It is as soon as one steps beyond the ground covered by these laws that debateable points begin to bristle on every side.

Prof. Worthington transmitted as part of the report of the Electrolysis Committee an account of some simple and interesting experiments he had made on the well-known discharging power, over electrified bodies brought near them, which flames possess. Several of these experiments suggest an electrolytic cause for this effect; dissociated and charged atoms being either drawn out of the flame on to the surface of the charged rod, or else the charge of such atoms is passed on to the rod by a sort of Grotthus chain set up in the air, the atoms themselves remaining behind. The former is the more natural idea, considering that air is not an electrolyte, but Mr. Worthington was impelled to the other, or Grotthus chain view, by the experiment of enveloping the charged rod in a blast of air, and perceiving that the action went on just as well through the blast. It was felt, however, by the Section that though such a blast might curve the paths, yet it need not stop the progress, of the charged atoms; and that their speed through air was likely to be greater than that of any easily practicable blast. Several of the experiments devised and quoted by Worthington are capable of easy and instructive repetition, however they be ultimately explained.

A most interesting communication from Prof. Schuster followed, with reference to the phenomena occurring in a vacuum tube, especially in the neighbourhood of the negative electrode. It has been long known and emphasised in Mr. Crookes' researches that electricity is conveyed in such tubes by a torrent of charged atoms driven in straight lines by electric forces with great speed from the negative electrode, the convection of such charges constituting a true current, capable, for instance, of being deflected by a magnet, and the impact of the atoms themselves being able to drive windmills as well as to raise matter to incandescence. Prof. Schuster now makes an attempt to measure the speed of this torrent of atoms by immersing them in a uniform magnetic field and observing the curvature of their path. He concludes that their speed is gradually reduced by collision until one of the stratifications or luminous layers is reached, when the collisions are so numerous that they are reduced to comparative rest, and the energy of their translation is transmuted into vibratory energy and radiation. He also, by means of tapping ring electrodes, succeeds in measuring the fall of potential along the tube, and shows that the great step of potential occurs close to the negative electrode, whence the torrent of negatively-charged atoms is impelled. A crowd of positive atoms await them across the interval of the well-known and remarkable "dark space."

The stratification layers in a vacuum tube are produced by an effect analogous to that which produces the ripple mark in tidal sand and the bars at the mouth of tidal rivers—so said Sir William Thomson; vaguely we have long supposed that the strata were regions of collision, and that the intervals between corresponded to free path, but we are now evidently getting nearer to a clear mechanical understanding of the processes, occurring in a vacuum tube, and of the discharge of electricity through gases, as a simple result of the presence of crowds of freely-moving charged atoms subject to ordinary electrostatic and mechanical laws.

After this the writer gave a hasty account of some experiments made in his laboratory on the effect of Metal Screens in warding off the quasi-electrostatic action of moving or varying charges. So long as a charged body is stationary, the thinnest film of conductor is of course perfectly effective in screening off the whole of its lines of force and forming a perfect electrostatic shadow in the interior of a closed space surrounded by it, but whether a bird-cage or tinfoil screen would be as effective for violently moving or varying charges was the thing investigated. It was found that so long as the walls were of ordinary thickness a gauze house or silver-coated beaker was completely impervious to any perceptible disturbance from without, the disturbance looked for being either a microscopic spark or else the microscopic deflection of a very light "needle," highly charged, positive at one end negative at the other.

But by coating beakers with thinner and thinner films of silver until the resistance of the coat increased from a fraction of an ohm to something like 70 or 100 ohms, a distinct deflection of the needle inside could be observed when a charged body was rapidly moved outside, or when a charged sphere outside

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was suddenly discharged. And when the film had as high a resistance as 1,000 ohms some metrical results were obtained. But all the films that thus permitted electrostatic actions* to penetrate them could also be seen through; and directly the film was thick enough to be opaque to light no perceptible trace of electric action could be got through it whatever was done to charged bodies outside. Doubtless there is a quantitative relation not expressible without regard to the violence of the original disturbance, and the phrase "opaque to light" is vague and not strictly defined, but such in general terms is the preliminary result arrived at.

Prof. Perry exhibited a variable standard of self-induction in a form which he proposes to issue for laboratory use, and which is likely to prove of great convenience. It is merely a pair of coils, one fixed, the other movable round an axis inside the fixed coil, so that it may be at any angle with its plane. The self-induction of the whole is composed of the self-induction of each coil separately, plus or minus twice the mutual induction of one or the other, according as they are turned to oppose or to help their separate actions. Such an instrument, in rude form, was already used by Lord Rayleigh, and its principle of graduation investigated by him theoretically.

It is not to be understood as a self-induction *meter*, but as a variable unit; bearing, in fact, the same relation to self-induction as a graduated rheostat does to resistance, but being likely to be a more reliable and satisfactory instrument than a rheostat, in that it is free from the defects of variable contact.

The defect at present of Prof. Perry's instrument seems to be its comparatively small range. It may be possible to increase this by having many coils instead of only two, though the plan of graduation to be adopted in such a case is by no means obvious at first sight. One might suggest that the various coils should be so connected with cogged wheels as to move from perfect discordance to perfect accordance in a regular and systematic manner when a handle is turned over a graduated spiral dial.

Mr. Preece described some experiments which he had instituted with the object of proving to himself and others that the theoretically predicted throttling by concentration of current to the periphery of conductors did really occur in actual practice with commercial alternating currents. The method adopted was to observe the elongation through rise of temperature of a number of conductors of different material (especially copper and iron) when powerful alternating currents were sent through them. Naturally, those that most obstructed the current would get hottest and so elongate most. Various frequencies were tried, and, as was to be expected, iron tended to heat abnormally much for high frequencies. Part of this is due to hysteresis, but another part is due to throttling. At immensely high frequencies theory asserts that all the heating will be due to throttling and none to hysteresis; at very low frequencies such extra heating as there may be will be due to hysteresis. At intermediate frequencies the two effects will be mixed up. The plan of observing expansion would not have struck one as satisfactory at first sight, for many reasons, but the results obtained seem to justify the method from a practical point of view.

Prof. H. Stroud described the result of some attempts he had made to obtain simple and direct evidence of the "Thomson effect" in copper and iron, by looking for an E.M.F. at the junction of hot and cold pieces of the same metal. He imagined that he had got the effect, but it is not at all clear to the writer how it can possibly be so. Prof. Stroud would admit that the Thomson E.M.F. does not depend on the steepness of the gradient of temperature, and that in a closed homogeneous circuit of non-uniform temperature the Thomson effects must therefore balance one another; how then can he hope to get a result by merely introducing a cut place with a violent step of temperature carefully maintained there? That he does get a result must be supposed due to some spurious or disturbing cause, unless evidence, not known to the writer, is forthcoming.

The curious photographic effect brought forward by Mr. P. Braham, as due to the action of a magnet's poles on a dry plate, was not regarded as proven by those in the Section most competent to judge. Such an action would be most interesting if established, but great care must be taken to be sure that no similar markings were on the plate before exposure to the magnetic field.

Few of the remaining Papers call for special mention; some of them had been published before. Prof. Blyth exhibited a current-weigher on the plan of an ordinary letter-balance. Prof. Silvanus Thompson projected on the screen the already well-known obstruction by crust of copper oxide when a current too intense for size of anode is sent through a copper voltameter. Mr. Swan described the use of chromic acid in preference to nitric acid in batteries. Prof. Perry described a future voltmeter on the plan of his beautiful spiral springs—an instrument of which we shall, of course, hear through other channels—and Mr. Bottomley exhibited his very interesting collection of cracked Leyden jars, already partially described, with comments by the present writer and by Mr. Boys, in *The Electrician* for March 29 and April 5 of this year.

* They cannot properly be called electrostatic actions—they are essentially electro-magnetic, but it is misleading to use either term in such a case.

THE ELECTROMOTIVE FORCES PRODUCED BY THE CONTACT OF SIMILAR METALS AT DIFFERENT TEMPERATURES.

BY SHELFORD BIDWELL, F.R.S.

In connection with the Paper read by Prof. H. Stroud at the recent meeting of the British Association (*The Electrician*, Sept. 27, p. 519), it may be of interest to give a short account of some hitherto unpublished experiments which were made by myself five years ago in the hope of throwing some light upon the nature of the electromotive forces set up when hot and cold wires of the same metal are made to touch each other.

In the first place, I convinced myself (rightly or wrongly) that the thermoelectric forces in question were not connected, at least in any direct and simple manner, with the electromotive force of the Thomson effect. This conclusion was arrived at mainly by consideration of the fact that when the hot and cold wires (or rods or tubes) are brought into actual contact, there cannot be any real breach of continuity in the fall of the temperature on either side of the maximum. The slope on one side may, indeed, be very steep, but it will never be an absolutely perpendicular precipice. Between the points of highest and lowest temperature there must necessarily be points at which every intermediate degree of temperature is represented in continuous succession; and, if this is so, then it seems clear that there must be *two* Thomson electromotive forces of equal strength, both of which act either towards or from the point of maximum temperature (according to the metal), and accurately balance one another. Thus no current at all can be started in the circuit by their agency.

A number of experiments made with iron, platinum, German silver, cadmium, zinc, silver, gold, copper, lead, tin, nickel and palladium confirmed this view. They, at all events, disclosed no correspondence of a simple nature between the Thomson effect and the direction of the observed currents, as will be seen by reference to the first three columns of the annexed table in which the results are given:—

Metals.	Thomson Effect.	Contact current. Hot to cold = +, Cold to hot = -	Thermo-currents.		
			Unstretched to stretched = +. Stretched to unstretch'd = -	Hammered to unhammered = +. Unhammered to hammered = -.	Unannealed to annealed = +. Annealed to unannealed = -
Iron	-	-	+	+	-
Platinum	-	+	-	-	-
German Silver.	-	+	-	+	+
Cadmium	+	+	+	-	-
Zinc	+	+	+	-	-
Silver	+	-	-	-	-
Gold	+	-	-	-	-
Copper	+	-	-	-	-
Lead	0	0	0	0	0
Tin	+	+	-	+	-
Nickel	-	+	-	-	-
Palladium	-	-	+	+	-

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The experiments were in every case repeated many times, and several different specimens of the metals were generally used. Special precautions were also taken to guard against errors resulting from oxidation.

The Table indicates a material point of difference between my results and those of Prof. Stroud. I found that in the case of copper, the current always passed from cold to hot through the junction, while, according to Prof. Stroud, it passes from hot to cold. While writing this Paper I have again tried the experiment with a new specimen of high-conductivity copper wire, and the current was clearly and unmistakably from cold to hot, as before. I will not attempt to conjecture the cause of this discrepancy.

As regards iron we are in agreement. With every specimen of wire that I used, whether thick or thin, annealed, hammered, or stretched, the current was always from cold to hot through the junction.

There is yet another point on which I venture to differ from Prof. Stroud. He says in his Paper (p. 520) with reference to the thermo-electric diagram, Fig. 1, which is here reproduced, "If copper kept at a high temperature indicated by position A in the diagram is placed in contact with an identical copper conductor kept at a low temperature, indicated by say, position B, we should, it seems to me, expect an E.M.F. to be established from hot to cold, seeing that the Thomson effect in copper is positive; or, in other words, since an electric current flowing through a copper conductor, in which there is a gradual fall of temperature in the direction of the current, has the effect of reducing the differences of temperature, we should expect the contact of hot and cold copper to give rise to an E.M.F. which would be in such a direction as to tend to reduce the difference of temperature, *i.e.*, from hot to cold."

I think there is a little misunderstanding here. The arrangement is not at all analogous to a bismuth-antimony circle, in which a current flowing in a certain definite direction would tend to equalise the temperature of two unequally heated junctions, by cooling one of them and warming the other. It is

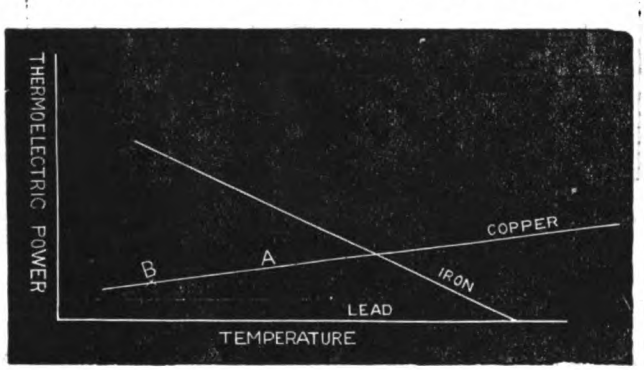

Fig. 1

true, indeed, as Prof. Stroud says, that a current flowing from hot to cold portions of a copper conductor would tend to reduce the differences of temperature. But so also would a current flowing in the opposite direction—from cold to hot. In the first case, however, the tendency to equalisation of temperature is caused only by the warming of the cold portion of the conductor; in the second case it results only from the cooling of the hot portion. In other words, when a current passes from a hot to a cold portion heat is *generated*, and when a current passes from a cold to a hot portion heat is *absorbed*. And this enables us to say at once that the direction of the Thomson E.M.F. in such a conductor must be from cold to hot, and not from hot to cold, as Prof. Stroud makes it.

Similarly, in the case of iron, in which a current tends to exaggerate differences of temperature, the direction of the E.M.F. corresponding to the Thomson effect is from hot to cold.

If this is correct—and it seems to me perfectly clear—it is certain that Prof. Stroud's experiments are not to be explained by the Thomson effect. For the currents which he observed were in both cases in the wrong direction. Nevertheless, his results are of great interest, especially those plotted in Fig. 3 of his Paper, and it is to be hoped that he will continue to prosecute his researches until the true nature of this mysterious phenomenon is revealed.

It may be as well to place on record here some further results obtained in my unsuccessful endeavour to connect the thermo-electric forces in question with a temporary or permanent change in the physical constitution of the metals, possibly due to heat. Three series of experiments were made. In the first the ordinary thermo-currents between temporarily stretched wires and unstretched wires of the same metals respectively were observed; in the second, those between hammered and unhammered wires; and in the third, those between annealed and unannealed wires. The direction of these thermo-currents is indicated in the last three columns of the table. Though the experiments failed in their immediate object, the results are not without some points of interest.

THE BIRMINGHAM EXHIBITION.

Ernest Scott and Co.—The chief exhibits of an electrical character shown by Messrs. E. Scott and Co., of Newcastle,

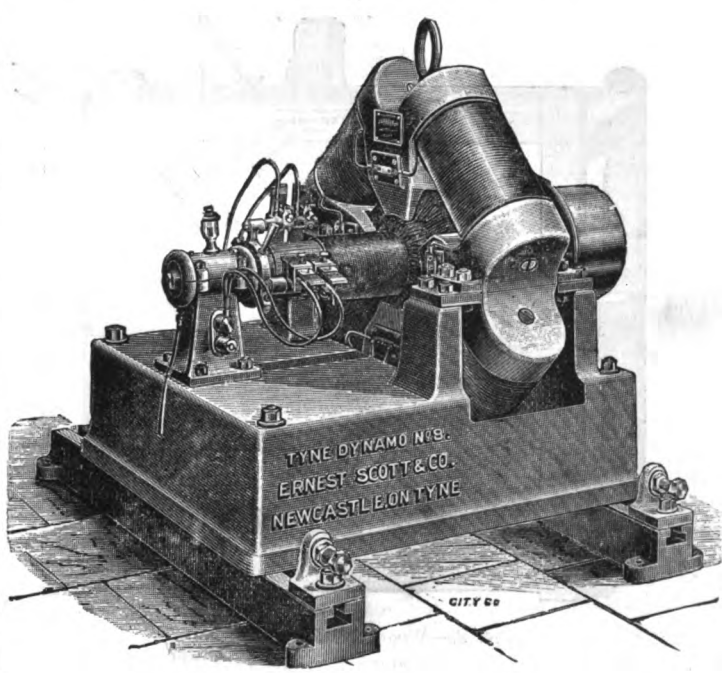

Fig. 2.—15-Unit "Tyne" Dynamo.

are a "Tyne" dynamo, a "Tyne" arc lamp, and a "magnetic separator." The "Tyne" dynamo (Fig. 1), is erected among the other machines and supplies six of their arc lamps in the main building. It is a 4-pole shunt machine. The field magnets, the form of which will be seen in the figure, consist of four soft iron cores bolted to the pole-pieces, which, are of cast iron; the two upper field magnet pole-pieces are each in one piece; the side poles, however, are in two pieces, so as to allow of the upper half being lifted without removing the lower parts. The armature is of the flattened ring type, and is wound with a single layer of wire of square section. In the 15-unit 65-volt machine exhibited there are 60 sections of four turns each, the wire being ·16 × ·14 section. To avoid the use of four brushes cross-connections are made. The spindle is of steel, with thrust collar to take up end play; the bearings are of cast iron, with adjustable keeps, and lined with brass shells, fitted with white metal. This construction has been adopted in preference to the ordinary method of running white metal into cast shells, and enables new brasses to be fitted in at a moment's notice, it not being necessary to heat the bearing to melt out the metal. The white metal itself is

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of special quality, made by Messrs. Ernest Scott and Co. for their marine and other high-speed engines, and is found to have double the wearing qualities of any other metal in the market. The commutator is of drawn copper, insulated by mica, and mounted upon a gun-metal sleeve, secured to the spindle by lock nuts and a feather. Owing to the powerful magnetic field of these dynamos and the small resistance of the armature the shunt machines are practically self-regulating. The "Tyne" arc lamp is used for lighting the bays, and, as well as the "Tyne" dynamo, has been designed by Mr. Mountain. The upper carbon rod is cut in the form of a rack, and gears into a pinion, carried on a spindle running in a sliding block in the inner frame of the lamp. This block is free to move vertically, and on the outside are two brake-wheels. Upon the brake-wheels there is a rocking lever carrying two friction chains. One end of the lever carries the iron core of the solenoid, and the other end the air dash-pot. When the current passes through the lamp the core is sucked up, tightening the friction chains upon the pulleys and raising the sliding block, and thus striking the arc. When the lamp is in its feeding position the sliding block rests on two adjustable stops, and as the current weakens in the solenoid the core is slightly lowered, releasing the friction chains and allowing the carbon rod to descend. These lamps are run in parallel, with resistances in series, as usual.

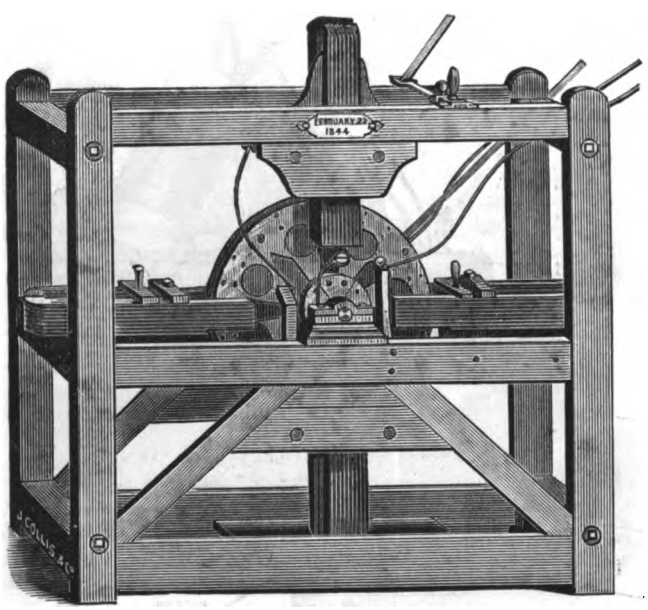

Fig. 2.—Woolrich's Plating Machine.

On their stand the company show a model of their "Magnetic Separator," which has been manufactured and used by them for the last two years. It consists of a strong frame-work on which are mounted two continuous bands passing over rollers, and moving parallel to one another in the same direction. The mixed iron and brass cuttings are thrown into a large hopper, at one corner of the machine, through which they are sifted on to one of the bands; they are then carried along under a large disc fitted with a number of electro-magnets with their poles downwards, which pick up the iron particles off the band, leaving the brass to travel onwards and fall into a box or sack at the end. The iron particles are carried round on the disc half a revolution and deposited on the other band, the magnetising current being at that moment automatically cut off.

Woolrich's Magneto-Plating Machine.—This machine has attracted considerable notice by reason of its venerable and somewhat uncouth appearance. A card attached to it states that it was invented by John Stephen Woolrich, of Birmingham, in 1842, and constructed by Messrs. Thomas Prime and Son in 1844. It has lately been presented to the City of Birmingham by the makers, and is exhibited by permission of the Mayor and Corporation. It is said to be the first plating machine ever constructed, and was used by Messrs. Prime and Sons in their business as electro-platers for many years. On the occasion of a British Association meeting Faraday visited Messrs. Prime and Sons' works to see this machine at work, and expressed great delight in seeing his discovery of electro-magnetic induction so early put to this practical use.

The general appearance of the machine is represented ie Fig. 2. The wooden frame carries four compound horse-shon magnets mounted with all their like poles on the same side, the poles all being directed towards the centre of the frame, and adjusted so that the armature can revolve between each pair. The armature coils, eight in number, are mounted between two brass discs about $\frac{1}{4}$in. thick and 2ft. in diameter. One set of ends are connected together and to a brass collecting ring on one side of the armature, whilst the other set of ends are joined to the insulated sections of a commutator on the far side.

Before reaching the commutator, however, the wires from the alternate coils are connected together by means of two independent copper rings to which they are soldered; thus the current from the four coils which are approaching or leaving the magnet poles at the same time can be collected from one commutator segment only. There are two brush-holders, however, and herein lies one peculiarity of the machine: one brush collects all the currents due to the sets of coils approaching the magnet poles, the other all those due to the coils leaving them, an independent connection being made with each brush so that two depositing baths could be worked at the same time.

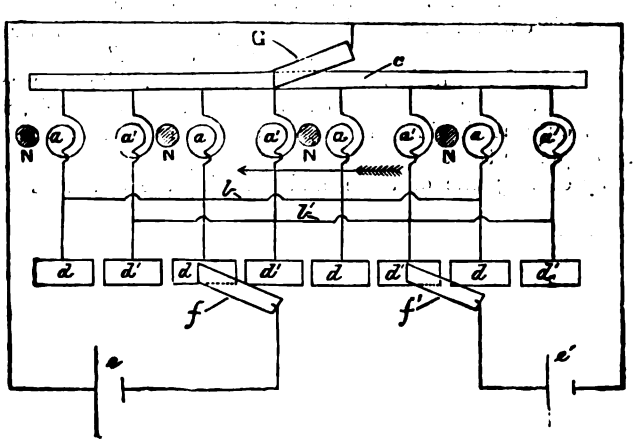

Fig. 3.

Diagram of the Connections of Woolrich's Plating Machine.

The diagram (Fig. 3) will make the action of the machine clear. For simplicity the arrangements are represented spread out flat. The magnet poles marked N (the S poles are not shown; they would, of course, be facing the N poles) are stationary, while the coils marked a and a', with their connections, are supposed to move in the direction indicated by the arrow. A current will be induced in the coils marked a as they approach the magnets, which will flow by way of the connections b and a commutator section d to the brush f, and thence to the plating bath e and back to the coils by way of the brush G. When the coils reach the centre of the poles, the brush f will be just leaving the commutator section d connecting with the coils a, while another commutator section connecting with the same set of coils will come under the brush f', and thus the reverse current as the coils leave the magnetic poles will pass through the bath e'; at the same time the coils marked a' will be approaching the magnets, and a corresponding section d' of the commutator will come under the brush f', and the same cycle of actions now takes place with the position of the two sets of coils with regard to the brushes reversed. Here, then, we have an armature with equi-potential coils connected together, so as to reduce the number of brushes required to a minimum. Truly there is nothing new under the sun!

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ON A NEW FORM OF CURRENT WEIGHER.*

BY PROF. JAMES BLYTH, M.A.

In the construction of balances for the measurement of electric currents a greater or less difficulty has always been experienced in leading the current into the movable parts of the instrument without seriously interfering with its sensibility. Several methods have been adopted to overcome this difficulty. In some balances the current is led in by mercury cups; in others flexible leads, made of thin wire spirals or thin metal strips, are employed, while in the recent balances by Sir William Thomson the difficulty has been overcome by means of his well-known ligature suspension.

Some time ago it occurred to me that still another form of balance might be employed for this purpose, and the present Paper is a short description of one which I have made.

The balance referred to is of the ordinary Roberval type, with the pivot connections all replaced by tightly-stretched torsion wires. It is constructed as follows:—

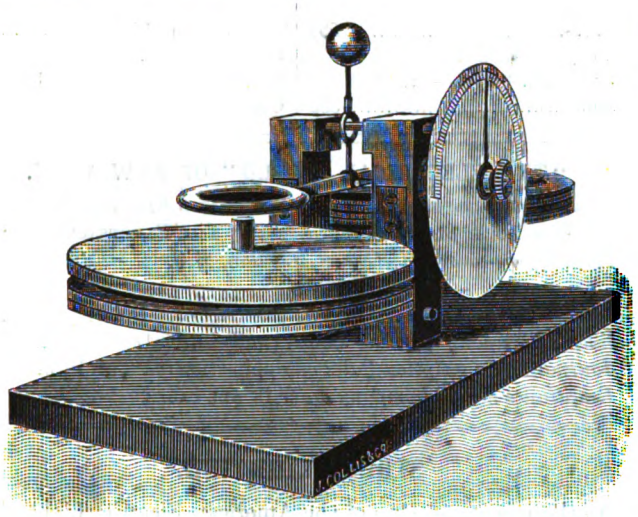

FIG. 1.

On a flat base-board (Fig. 1) are placed two vertical uprights of wood or other insulating material, about six inches apart. Between these are stretched two parallel wires in the same vertical plane about three inches apart. To the middle points of these wires are soldered the two horizontal metal bars of the Roberval. These are about nine inches long. Both horizontal bars terminate at each end either in forks or rings, placed in a horizontal plane, and wires are tightly stretched between the prongs of the forks or across a diameter of the rings. To the middle points of these last wires are attached, also by soldering, the vertical bars of the balance, thus completing what takes the place of the ordinary jointed parallelogram of the Roberval.

The vertical bars have metal terminals, insulated from each other, and carry the circular discs, on the rims of which the movable coils of wire are wound. The bars pass at right angles through the centres of the discs, and are fixed to them at their middle points. The fixed coils, which are of exactly the same diameter as the movable ones, are supported from the base-board, and are placed so that one is about half an inch above one movable coil, while the other is as much below the other movable coil. From this it will be seen that when the balance is in equilibrium the fixed and movable coils are all horizontal, with a space of about half an inch between each pair.

The stretched wires may be either of steel or phosphor-bronze, and before being finally soldered are placed under considerable tension.

The current flows through the instrument thus:—Entering, say, by the upper wire connecting the fixed supports, it passes to the upper horizontal bar. There it splits into two, one half (supposing the resistances equal) passing to each end of the bar, and, by means of the corresponding fork-wires, passing through the movable coils. From the movable coils each half returns along the lower horizontal bar and together pass out by the lower wire connecting the two main supports. From this the whole current passes first through the one fixed coil and then through the other, and in such a direction as to produce a repulsion between each pair of coils.

In the constructing care is taken that the suspended coils are both made of equal weight, and that when the balance is in equilibrium no torsion is in any of the wires. Small scale-pans are attached to each vertical bar, and a bob for raising or lowering the centre of gravity of the whole is placed on a rod springing at right angles from the middle of one of the horizontal bars.

The current strength is estimated by the weight needed to restore the balance to equilibrium when disturbed by the passage of the current. A sliding weight may also be used, as in a steelyard.

It will be readily seen that, as in all forms of current-weigher, the weights are proportional to the square of the current strength.

Another form of the instrument, which is in reality a torsion balance, is represented in Fig. 2. It differs from the previous form in this, that all the coils are in a vertical plane, with the torsion wires also vertical, while the current is measured by the

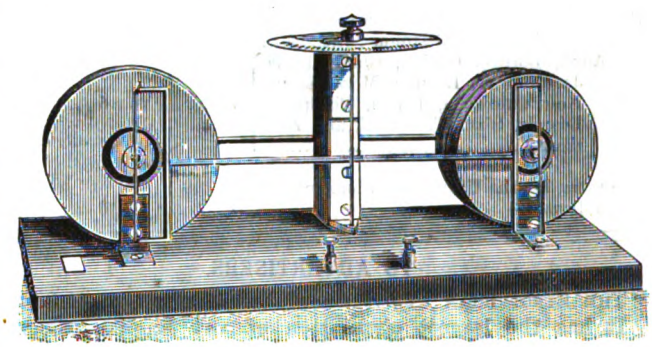

FIG 2

number of degrees of torsion that must be given to the one end of one of the torsion wires in order to bring the balance to equilibrium. If the connections be considered, it will be seen that no current passes through the wire where torsion rigidity is used to measure it, and also that the current is so distributed among the other wires that only one-fourth of the heating effect is produced on each of them which would be produced if the entire current went through them. In this way any inaccuracy due to the heating of the wires is reduced to a minimum. The balance exhibited, though little more than a model, had a resistance of 360 ohms, and is quite sensitive to one-tenth of an ampere.

* Paper read before the British Association in Section A, Newcastle-on-Tyne, September 1889.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, October 7th.

SOCIETY OF ENGINEERS.

7:30 p.m. Ordinary Meeting at the Town Hall, Westminster. Paper to be read, "Pin-connected *v.* Rivetted Bridges.' By J. H. CUNNINGHAM, A.M.I.C.E.

TUESDAY, October 8th.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture: "Scenes from the French Revolution." By A. H. GILKES.

WEDNESDAY, October 9th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Ordinary Meeting.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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Owing to the increase in the number of pages of "THE ELECTRICIAN," in order to partly cover the increased postage, we have been compelled to revise the rates for Foreign Subscriptions, which are now as follows:—

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THE DIRECTORY for 1889 is NOW READY.

And the issue for 1890, which will be still further enlarged and improved, is in preparation. New Names and Addresses, Corrections, Advertisements, &c., should be forwarded to the Publishing Office, 1, Salisbury-court, Fleet-street, London, E.C.

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STREET LIGHTING.

At the recent meeting of the American Electric Light Association, it was stated by Mr. WEEKS, in his Presidential address, that the number of arc lights now in service in the United States is 237,017, being an increase of over 17,000 on the past six months. No distinction is drawn between the lamps employed in street lighting and those used for private purposes, but we believe the number is supposed to be about equally divided. The total number of incandescents in use is given as 2,704,768, showing an increase in the same period of a little over 200,000 lamps. (Although it does not directly concern the subject we have in hand, we may add, upon the same authority, that there are now 109 street tramways operated by electricity in the States, which employ 936 motor cars.) Returning to the lighting business, we note that, roughly speaking, it may be said that the total horse-power employed in the service is about equally divided between arc and incandescent lighting, and therefore, if our previous assumption is anywhere near the mark, about one-fourth of the central station output in the States is devoted to street-lighting. In this country, although, unfortunately, we have no authoritative statistics to go upon, yet there is not the least doubt that the ratio, so far from being equal, is more like 20 to 1 in favour of the incandescents—we refer as before to the total horse-power employed—whilst the existing street lighting probably accounts for scarcely 5 per cent. of the total number of arcs in use. In the States there are a great number of flourishing stations still wholly devoted to arc lighting, whilst with many others the incandescent work is quite subsidiary. Stations of this kind are not, indeed, wholly unrepresented in this country, and such as do exist have, as a rule, attained a very fair measure of success. The fact is, as every electrician knows, that

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in an arc-lighting installation designed chiefly for street lighting, both the technical and economical problems can be solved with far greater ease and certainty than is the case with a house-to-house distribution of incandescents. Both capital-outlay and working expenses can be estimated to far greater nicety, and the exact hours of lighting are usually known beforehand, so that the preparation of estimates presents little or no difficulty. Add to this that as a rule the load is always fully on or fully off and that the working hours are from three to four times as long as the average for incandescents, and it is sufficiently clear that *if only a fair price can be obtained* street lighting ought to afford a valuable source of revenue to the electric lighting companies which are everywhere springing up. The public mind is at the present time somewhat excited about electrical affairs, and it is allowing itself to indulge in visions of outdoor brilliancy which the local authorities have in very few cases as yet taken any steps to realise. The result will probably be that as soon as some of the big stations get into operation there will be an outcry on the part of the public for better street illumination, which the local authorities will be unable to resist. Electric lighting companies will then have a chance, which we hope they will have the wisdom not to throw away.

It is, however, much to be desired, both for the sake of the public and for the sake of the Companies, that where the work is put up to public tender, the number and disposition of the lamps should be explicitly stated in the specification. Experience has shown that if two or more Companies in competition be allowed to use their own individual judgment in this matter, the result is almost certain to be unsatisfactory. The public want the electric light because they wish to see the streets better lit, and this cannot be done by merely increasing the brilliancy of the lamps, if their number be more than proportionately diminished. It is sufficiently evident that if the question is left open the company must always be tempted to underestimate the amount of light required—not perhaps without an inward expectation of later extensions when the results are made manifest. Meanwhile the public are disappointed and dissatisfied, and the light is either pronounced a failure, or additional funds are grudgingly voted. This has happened already at least half-a-dozen times in this country, and is happening at this very moment in a town which we, for the present, forbear to name.

For this reason we are strongly of opinion that, equally out of regard for the public and in justice to the Companies themselves, they should not be asked to tender to any street lighting specification in which the number and distribution of the lamps is not definitely set forth. The question is one not wholly devoid of difficulty, but it ought not to be beyond the compass of the local surveyor or the borough engineer, or whoever the functionary in charge of the existing street lighting may chance to be. The mistake which should above all others be avoided is that of having the lamps so few and far between that passengers find themselves now in dazzling light and then in s mi-darkness. The greater the intrinsic brilliancy of the lamps the more pronounced is the evil. The remedy is obviously to have a sufficient number of lamps, to place them at a sufficient hei ht, and to take into consideration the width of the thoroughfare, the nature of the traffic, and anything else which can effect the resultant character of the illumination, before finally deciding the question. Doubtless some skill and knowledge is required for this, and with greater experience better results will be obtained, often for less money. Meanwhile, the responsible officers may learn much by visiting some of the towns where arc lighting already exists, and making a few intelligent observations as to the results obtained and the arrangements adopted. From the nature of the case it is clearly impossible to lay down many general rules, but the following illustration may possibly be of some service to the class for whom it is intended:—Take the case of a quite straight thoroughfare, one mile in length, and 60 feet in width. Such a street could not be efficiently illuminated with less than 30 to 35 arcs of 2,000 c.p. (nominal) mounted upon poles from 24 to 30 feet in height, and placed, of course, on alternate sides of the road; if furnished with the dioptic lantern or some other suitable means for economically distributing the light so much the better. In cases where the introduction of electric lighting necessarily means the total abandonment of gas for the public service, the difficulty may be economically met, as in Taunton, by lighting lanes and alleys with oil lamps.

But whether, after all, arc lighting affords the best and final solution of the street-lighting problem is a point quite open to consideration. In the States not a few towns have abandoned arc lighting in their streets in favour of incandescents. In this country repeated efforts have been made to introduce incandescents for the public service, and we cannot point to one instance in which a satisfactory result has been attained. As we have repeatedly pointed out, those attempts were from the first foredoomed to failure, because in the expectation of the public "electric light" necessarily means a glare. The time will probably come when they will have been educated beyond this point, and will agree with us in thinking that about 500 candles in an incandescent, or 300 to 400 in an arc, is as much light as needs to be concentrated in a single lamp for the lighting of ordinary streets. However, we are not yet quite ready to supply such lamps—not at least at current rates—so perhaps it is as well that the demand is not over-pressing.

PARIS EXHIBITION AWARDS.

The following is a complete list of the awards of the International Juries to the electrical exhibitors of the British Section of the Paris Universal Exhibition:—

GRAND PRIZE.

Elliott Brothers.

GOLD MEDAL.

Crompton and Co.	John Fowler and Co.
Eastern Telegraph Co.	Latimer Clark, Muirhead and C

SILVER MEDAL.

Electrical Power Storage Co.	Henley's Telegraph Works Co.
Paterson and Cooper.	Sunbeam Lamp Company.

BRONZE MEDAL.

Automatic Electrical Corporation.	Chubb and Sons Lock and Safe Company.
Davis and Timmins.	

HONOURABLE MENTION.

Acme Electric Works.	Globe Electrical Engineering Co.

In addition to the above awards in Class 62 the following well-known firms have obtained awards:—Messrs. Aveling and Porter, who exhibited amongst other things a combined traction engine and dynamo, a gold medal; Messrs. W. and T. Avery, of Birmingham, who exhibited one of Snelgrove's electric balances, a silver and a bronze medal; R. Aylmer, a bronze medal; the Blackman Ventilating Company, a bronze medal; Crossley Brothers, a gold medal; Messrs. Davey, Paxman and and Co., two gold medals and one silver medal; Samuel Elliott, a silver medal; W. and J. Galloway and Sons, a grand prize; Messrs. Greenwood and Batley, a gold medal; J. Kirkaldy (Limited), a silver medal; Messrs. David Moseley and Sons, honourable mention; the North British Rubber Company, one gold and one silver medal; Messrs. Selig Sonnenthal and Co., a silver medal and an honourable mention; A. I. Timmis, a silver medal.

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PURIFICATION OF SEWAGE AND CONTAMINATED WATER BY ELECTROLYSIS.*

BY WILLIAM WERSTER, F.C.S.

When some months back your Committee did me the honour of asking me to read a Paper on the Electrical Treatment of Sewage, I accepted the privilege with many misgivings, as, unfortunately, my time is so much occupied in the routine of business that I felt it would be impossible to prepare a Paper worthy the attention of this assembly. Having accepted the responsibility, I have done my best to put the subject before you clearly, and must crave your indulgence for any shortcomings.

The increasing populations of our large towns has made the question of sewage purification a very pressing one, particularly in relation to the purity of our rivers, most of which unquestionably are in a serious state of pollution. The sewage question generally has become of such importance in reference to public health, now and hereafter, that it is evident steps must be taken as quickly as possible to remedy the present condition of things, and to maintain as high a standard of purification as is compatible with the enormous quantities with which we have to deal.

It may be that the present scientific knowledge is not sufficient to entirely and finally deal with this question. We should, however, aim at as high a standard of purification as possible—it is of no use to try half measures—and whatever the treatment may be, my contention is that the nearer Nature's action is approached, the nearer the solution of the difficulty. Any new process requires thorough investigation, and it is for this reason that my experiments have taken up so much time, the success of certain laboratory experiments having been made public quite eight months before I was able to start a series on anything like a working scale, and since that time my connection with other undertakings has rendered it very difficult for me to concentrate attention except for short periods at intervals.

The oxidation of organic matter can only be attained by one mode—chemical action—whether it be by filtration, the addition of chemicals, or by mechanical force represented by the electric current.

Sewage is a most complex compound, whose component parts depend upon the water supply of a town, in some cases upon the rainfall and the industries of the locality. Householders and owners of factories would much assist local authorities in the end aimed at if they would disinfect their refuse before it passes into the sewers; thus one of the most objectionable features I have noticed in London sewage is the large amount of organic matter floating on the surface with an obnoxious odour. I am not quite certain of its source, but it is evidently of a nature that points to gas works or tar distilleries, also certain dyes and tan refuse which require more treatment than sewage itself. I know that the manufacturer is at a loss where to put his waste products, and it is an extremely difficult question for the public to solve; but it is a moral certainty that, if the sanitary authorities of our cities and towns have to purify their sewage, the taxpayer will decline to pay for the treatment of manufacturers' refuse when it is known that sewage alone requires very much less expenditure on purification than when it is mixed with complicated waste compounds of a chemical nature. The great object in view is to prevent putrefaction, and it may not be out of place to state the means of arresting it.

The question is, what is putrefaction? Putrefaction is a spontaneous change common to all organic bodies when exposed to the air; the action is accompanied by the evolution of unpleasant gases, which are, for the most part, compounds of sulphur and phosphorus; it differs from decay, as it is not oxidation; the presence of air is essential only at the commencement of the action, and not after it has fairly set in. Modern science teaches us that air may be the carrier of ova which induce the change. Any dry matter does not putrefy; intense cold prevents putrefaction.

The atmosphere acts mechanically by its power of removing foul vapours, and chemically by their oxidation.

* Paper read before the British Association in Section G. Newcastle-on-Tyne, September, 1889.

Water—its action is largely mechanical. Thus in a river organic matter becomes separated, and oxidation takes place by reason of the air dissolved in it; showers of rain purify the air, and the molecules of water forming the rain act as carriers of oxygen.

The soil, as manifested in our graveyards, the iron oxides in the soil acting as purveyors of oxygen, and owing to its porosity causes the oxidation of putrefying matter. Intense heat and light also play important parts in disinfection.

Sewage farms can only be successful when the porosity of the soil is adapted for filtration, and when the area is sufficiently large for the work it has to do; but all sewage before being run upon the land should be treated so that secondary putrefaction cannot be set up.

The organic matter should also be disintegrated, so that the pores of the natural filter shall not be blocked up by it when in a state of semi-solution. Greasy matters should be removed, as they also have a tendency to block up the soil.

Before entering into the particular subject of my Paper, I must ask you to glance at the list of a few of the chemical processes which have been tried in various parts of the world during the last 120 years.

Name of Substances.	Inventor.	
Sulphate of iron	Deboissieu	1762
Chlorine	Halle	1785
Lime	Estienne	1802
Powdered charcoal	Giraud	1805
Chlorine and chloride of lime	Guyton Morveau	1805
Ashes	Chaumette	1815
Sand	Duprat	1818
Sulphate of iron	Briant	1824
Chloride of soda	Labarraque	1824
Waste chloride of manganese	Payen and Chevalier	1825
Sulphate of lime	Siret	1827
Animal charcoal	Frigerio	1829
Peat	Guibourt and Sanson	1833
Charcoal and calcined marl, or river mud	Pottevin	1836
Sulphates of iron and zinc with tan and tar	Siret	1837
Earth, lime and waste substances	Rossier	1837
Peat ashes	D'Arcet	1840
Metallic oxides and carbon	Krafft and Suequet	1840
Chloride of zinc	Sir William Burnett	1840
Schist coke	Hompesch	1841
Trade refuse, charcoal and ashes	Albert	1842
Powdered lignite	Jourdan	1843
Impure alum	Siret	1843
Sulphate of zinc, charcoal and clay	Gagnage and Regnault	1844
Persulphate of iron	Baronnet	1845
Schist coke	Du Boisson	1845
Chlorides of iron and zinc	Dubois	1846
Lime and precipitating tanks	Higgs	1846
Nitrate of lead	Ledoyen	1847
Waste salts of iron, lead, zinc, &c., with pyrolig matters, ashes, &c.	Brown	1847
Pyrolignate and perchloride of iron	Ellerman	1847
Impure chloride of manganese	Young	1847
Dried seaweed, lime, and sulphate of lime and zinc	Salman	1848
Peat charcoal	Rogers	1848
Charcoal, soot, mineral salts, &c.	Legras	1849
Spent tan, carbonised	Tarling	1850
Fresh bark, sulphate of iron, and peat charcoal	Angely	1850
Metallic sub-salts, as of iron, alumina, &c.	Browne	1850
Milk of lime and collecting the deposit	Wicksteed	1851
Acids and metallic salts, and filtrations through charcoal, clay, peat, gypsum, &c.	Dover	1851
Lime, sulphates of alumina, and zinc and charcoal	Stothert	1852
Lime, magnesian earth, sulphate of zinc or iron, and vegetable charcoal	Gilbee	1852
Sifted ashes, breeze, or peat charcoal	Perks	1852
Sulphate of zinc, potash, alum and sand with waste tan, ashes, lime, soot, &c.	Pinel	1853
Metallic sulphates, metallic chlorides, or charcoal and magnesian salts	Herapath	1853
Salts produced in working galvanic batteries	Dering	1853
Peat or bog earth containing salts or oxides of iron	Dimsdale	1853
Peat and other charcoal and chloride of sodium, &c.	Macpherson	1853
Animal charcoal, alum, carbonate of soda, and gypsum	Manning	1853
Magnesia and lime with sulphurous and carbolic acids	Smith and McDougall.	1854
Lime and finely-divided charcoal	Wicksteed	1854
Boghead coke	Herapath	1854

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Name of Substances.	Inventor.	
Soft sludge from alum works, with lime and charcoal	Manning	1854
Peat charcoal carbonised with oil of vitriol	Longmaid	1855
Alum schist or shale, and other aluminous minerals, with lime and charcoal	Manning	1855
Manganates and permanganates	Condy	1857
Superphosphate of lime with magnesia and lime	Blyth	1858
Sulphate of iron with lime in solution (recommended only), &c., &c.	Letheby	1858
Spongy iron	Bischoff	1865
Iron finely divided in revolving cylinders	Anderson	1884
Iron sulphate Aluminium sulphate Calcium sulphate Magnesium sulphate Silica Black oxide of iron	Named Ferrozone	1887

It is I fear true that many of the methods enumerated, and most of those not enumerated, have not only failed to meet reasonable expectations as to their physical and sanitary characters, but they have also proved in many cases costly failures; and it is a remarkable fact that claims have been made within the last five years in reference to sulphate of iron by itself, or in combination with other materials, as if it had only just occurred to the chemical mind that these substances ought to be tried. On reference to this list, you will notice that the first five, dating from 1762—1805, are practically identical with those of recent date. In 1843 alum seems to have been tried, and in 1857 manganates and permanganates; the latest development of sulphate of iron is under the name of ferrozone. It was while working with perchloride of iron as a purifier of sewage that I first learned the importance of iron salts in relation to organic matter, and it was in connection with this chemical and free chlorine gas that the idea of electrolysis suggested a possible mode of treatment of water contaminated with organic matter. Sulphate of iron has one great drawback—the production of sulphide of iron due to the organic matter combining with the oxygen of the salt. In nature we have iron pyrites, known as the bisulphide of iron, which is produced by the deoxidation of sulphate by organic matter. The sulphuretted hydrogen in sewage is entirely due to the same action on the sulphates contained in it; it therefore follows that sulphates should not be added, as they only increase the nuisance instead of abating it. Sulphuric acid added to manganate of soda and run immediately into the sewage is sure to lead to objectionable reactions. The very fact of adding chemicals means adding water, thus, to a certain extent, producing a seeming purification. The following illustration will show this:—

Ten grains of lime added to a gallon of sewage in the form of lime water means the addition of one pint of water; it therefore makes an apparent purification of 12·5 per cent. by this increase of water. I have here a list of analyses taken from the Appendices of the Report of the Royal Commission on Pollution of Rivers; my experience being that lime produces after-putrefaction if used alone or with sulphates, and if used in large quantities is also sure to set up after-precipitation when the resulting effluent is run into river water.

I have already stated that putrefaction means sulphuretted hydrogen. On the West Coast of Africa the water contains large quantities of sulphuretted hydrogen, its formation being due to the presence of organic matter and sulphates. I believe I am right in saying that this particular portion of the African Coast is known as the Sailors' Death-trap.

Of artificial disinfectants chromic acid is the strongest, sulphurous acid the weakest among mineral acids. Permanganates oxidise dead organic matter under certain conditions, but unless in very concentrated solutions, have little or no action on disease germs. Chlorine gas or oxides of chlorine are the most powerful disinfectants.

The fact that water is easily decomposed, provided the current electricity is of sufficient intensity, and also that the effects produced are precisely in accordance with the chemical equivalents of the substances electrolysed, is practically the explanation of the whole system; for the chemical changes that take place in sewage when it is electrolysed depend chiefly on the well-known action that sodium, magnesium, and other chlorides (which are always present in sewage) are split up into their constituent parts. Thus we have at the positive pole chlorine and oxygen set free, and these elements are liberated in a nascent state, a condition in which they are intensely active, so that the organic matter in the sewage is rapidly oxidised into innocuous compounds. So rapid is this action that, provided the sewage contains a sufficiency of chlorides, it is possible to produce a disinfecting fluid from it consisting of oxides of chlorine.

As mine is an artificial action, I will take the two disinfectants which are formed in my process, iron oxides and chlorine: the first a purveyor of oxygen; the second, in the form of hypochlorites or chloric acid, absolutely destroys organic matter, living or dead. By using non-oxidisable plates, such as carbon for positive pole and iron at the negative pole, with a porous diaphragm between them, I am able to collect the component parts of the mineral salts; therefore at the non-oxidisable plate I obtain a solution of chlorine and oxide of chlorine, and at the negative plate I obtain ammonia, soda, and potass, which in their turn precipitate any lime and magnesium salts that may be present in the liquid. So strong is the action of oxide of chlorine that it is only one form of carbon plate that will resist disintegration.

My first experiments carried out in this manner were conducted with platinum plates, but the experience was that the cost of platinum put it out of the question, besides which there was a very slight action on the positive plate which distinctly pointed to its ultimate destruction. There being no precipitation in the sewage of matter in suspension, by means of an arrangement, which consists of a porous pot with a non-oxidisable plate such as carbon for the positive electrode and iron plates for the negative electrodes, I am able to manufacture the before-mentioned solution of oxides of chlorine from brackish sea-water or sewage. The water of the River Thames near Barking is admirably suited for this purpose. It is possible that an objection may be raised that the resistance of the porous pot to the electric current would be so great that the cost would render it an impossibility from a commercial point of view, but the very fact of using salt water balances the extra resistance caused by the porous diaphragm, and for every ampere of current that is used per hour I produce 18 grains of nascent chlorine, or an equivalent of the oxides of chlorine. My experience of nascent chlorine as a disinfectant is that about one-third of a grain is capable of disinfecting one gallon of London sewage (first removing the matters in suspension), and on examination the presence of nitrites is detected, which shows how far the oxidation has been carried. This action, combined with the treatment with iron plates, hereafter described, will, if carried far enough, absolutely eradicate all organic matter. And here it will be as well to mention that the resulting effluent must not have an acid reaction, otherwise fungoid growths appear on the surface after a few hours. The forms in which these apparatus are best applied on a small scale, with porous diaphragms, are as follows:—First. An outer vessel, which may be made of iron—the sides in that case acting as negative electrodes—and an inner vessel containing the carbon electrode. By means of a syphon connected with a reservoir or tank, containing, say, sea water or salt and water, the inner vessel can always be kept supplied with the saline solution, and by an easy automatic arrangement it is possible to draw off a given quantity of disinfectant solution when formed. By placing an oxidisable plate in the same pot as the carbon, and connecting the two to the positive pole of the current, I can produce a hypochlorite or chloride of the metal used, which will thus further assist the resulting action. The many uses to which these disinfectants can be applied I need not enlarge upon. Six small cells of the latest form of the Leclanché type are quite sufficient for producing the necessary power for making two or three gallons of the chlorite solution during the day, and they will last for several months without recharging, it being understood, of course, that they do not remain continuously in action. The apparatus on a large scale may be variously modified according to the strength of the solutions of chlorides acted upon.

By applying the current to a carbon filter as arranged (Fig. 1) I am able to oxidise the organic matter in water. The positive pole being the porous carbon block, the nascent

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oxygen produced in the pores of the carbon by the electric current absolutely destroys the organic matter, bacteria being killed and the filter block itself kept clean. The action of porous carbon by itself is due to its power of absorbing noxious gases and effecting their destruction by bringing them into contact with atmospheric oxygen, but it is absolutely essential that there should be a free supply of air; how much more active the action is when nascent oxygen, and even chlorine, are constantly supplied to the pores of the carbon by means of the electric current can be easily imagined. As an example, the following analysis before and after action may be of interest :—

FILTER EXPERIMENT ANALYSES.

Parts per Gallon.

—	Appearance.	Odour.	Oxygen required to oxidise the organic matter.
Before action—Dilute sewage	Turbid	Bad	0·93
After action—Nitrites present	Clear	None	·17
Before action—Contaminated water.	Slightly turbid	Slight	·06
After action—Contaminated water ..	Clear	None	·00
Before action—Dilute sewage	Turbid	Bad	0·82
After action—Ordinary carbon filter	Slightly turbid	Slight	0·4
After action—Electric filter	Clear	None	0·13

Current used 0·5 ampere.

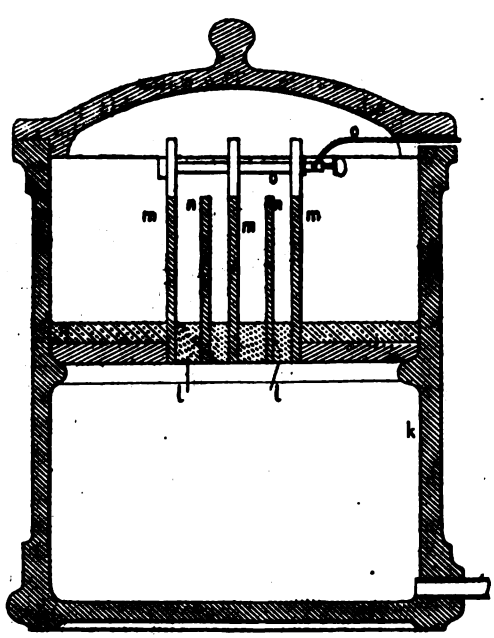

FIG. 1.—Filter for Household Purposes.

k, stoneware vessel; *l*, porous filtering material; *m m*, carbon electrodes connected by conductors *o* to the + pole of the battery; *n n*, carbon electrodes connected to − pole.

For the purposes of this filter, an ordinary form of stoneware, divided so that the lower compartment contains rather more than the upper, is used; a carbon block is fixed in the usual position, and round this block two pieces of asbestos twine are tied; at the top of the block a platinised screw terminal is fixed; this forms the positive electrode. For the negative electrode, carbon rods are arranged so that they press on the asbestos twine; they are all connected together by means of a carbon disc at the top, also provided with a screw terminal, or, instead of the rods, a carbon cylinder may be used. All that is required is to attach these terminals to the respective terminal of a battery, consisting of three Leclanché cells, arranged in series. The action is automatic, as when the top compartment is full the battery is in action, when empty it is at rest.

On a large scale I have the filter arranged somewhat in the form shown in Fig. 2. Alternate layers of small coke free from sulphur are separated either by layers of sand or perforated tiles; by suitable connection these beds of coke form positive and negative electrodes, the first layer of material being sand, so as to mechanically separate matters in suspension. It is impossible for disease germs to propagate, owing to the nascent oxygen and chlorine produced when the filter is in action.

Another form is by embedding non-oxidisable plates in sand with or without porous diaphragms. The necessary electric current in this case would, of course, be taken from a dynamo. For the treatment of sewage it is absolutely necessary that precipitation of the matters in suspension should take place, and the more complete this is the better the ultimate result.

To produce this I employ oxidisable plates of such material that they shall have no poisonous after-effects either on land or in rivers. The metals should be either aluminium or iron, but the first-named is out of the question owing to cost, and then iron, besides having the advantage as regards price, in the form of oxide has many valuable qualities, one of the chief being that sulphuretted hydrogen cannot exist when ferrous or ferric oxides are present. It is well-known that oxide of iron in the hydrated form is largely used for purifying coal gas from sulphuretted hydrogen.

The electric action is easily explained practicably (experiment shown of action of small iron plates connected with a battery, two plates being positive and two negative; sewage acted on in cylindrical glass vessel). At the positive pole the chlorine and oxygen given off combine with the iron to form a salt, which I am persuaded is, for the moment, a hypochlorite of the metal,

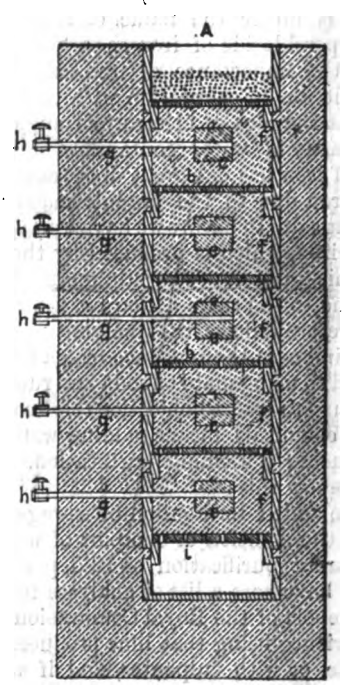

FIG. 2.—Filter arranged for operations on a large scale.

A, sand; *b*, perforated tiles; *c g h f*, carbon electrodes; *i*, channel for exit of filtered fluid.

but it immediately changes into a chloride, which in its turn is deprived of chlorine to form ferrous carbonates and oxides. During the chemical action carbonate of iron exists in solution, and its formation is due to the presence of carbonates in the sewage, chiefly carbonate of ammonia. In samples that are absolutely free from dissolved oxygen, the ferrous oxide in the white form is precipitated, and on shaking up with air it changes to the usual pale green colour; the carbonate of iron at the same time being oxidised, the ultimate precipitate is red, known as ferric oxide, Fe_2O_3, and I have noticed that sometimes this changes after a time back again to the ferrous state Fe O, thus showing that it has acted as a carrier of oxygen to the organic matter present. On a small scale the precipitate is carried to the top, due to the bubbles of hydrogen collecting round the particles of matter in suspension, but it ultimately sinks in the usual manner. In practice the precipitate does not rise, owing to the larger evaporating area, which allows the escape of the gases produced. The current required for the action varies with the

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nature of the sewage; but in this case I am using an ampere of current, and the amount of sewage is one-eighth of a gallon. It is usually assumed that 1·5 volts are required for splitting up water into its component parts; this may possibly be true with carbon plates, but with iron plates acting on sewage I can obtain the same result with ·9 volts as with double the intensity; of course, it takes a longer time, for with such a low voltage the quantity of current is small.

An ordinary sample of sewage requires, on an average, one ampere of current for 10 minutes per gallon, but when mixed with foreign matter, such as manufacturers' waste products, the amount required can only be estimated by experiment. The small plates I used in the experiment are of wrought iron; on a larger scale I use cast iron of the commonest "pig" quality, which is only one-third the cost and has the virtue of not scaling. Most of my experiments have been carried out with wrought iron sheet, which has the disadvantage of scaling, but on account of its lightness is more suitable for experimental work. The plates themselves should always be kept under water, so as to prevent the formation of the red oxide on the surfaces; and the action should be continuous as far as possible, for if continuous the plates seem to acquire some property which reduces the resistance to the electric current, and therefore lessens the cost. At the beginning of a month's run which lately took place, the voltage measured across certain plates was 3, but after a few days only 1·79, and doing the same work. On examining the plates freshly taken from the liquid they were in, I found a thin coating of the black, or magnetic oxide of iron, which has the property of preventing the rusting of the plate under water when the electric current is cut off.

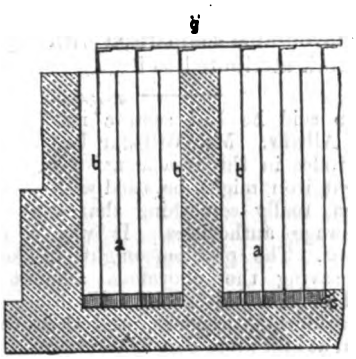

FIG. 3.—Brick Channels with Iron Electrodes in position.

a, negative; *b*, positive; *c*, asphalte; *g*, main lead.

For 1,000,000 gallons sewage flow, 24 hours, the complete plant necessary is:—engine, dynamo, and boiler-house; two engines and boilers, each 12 horse-power nominal; two dynamos, brick shoots with culverts at side, two settling tanks, sludge tank, sewage culvert, treated sewage culvert, cast-iron plates, copper conductor, measuring instruments. Where the effluent has to run into a small stream or river a suitable tank would have to be constructed for arranging the electric filter as before described.

The drawing Fig. 3, representing the plates in position, shows that a channel is kept at the bottom of the electrodes for the silt to collect, with a culvert at side to flush it into so as to prevent any block occurring, but the advantage of this is obvious. The plates in each section are about an inch thick, and can be of any length up to 6 feet; it may be possibly objected that a large number of plates is required. This may be so, but the larger the number of plates the less the engine-power required, and the longer they last. In each section the electrodes are in parallel, and any one section is in series with the other, the arrangement being exactly like that of a series of primary battery cells.

By actual experience I have been able to prove that at least 25 sections of electrodes should be in series, and across any one of these sections the potential difference need not be greater than 1·8 volts, the current being of any desired amount according to the surface of plates used. In experiments that were lately carried out I used a current of 370 amperes, which was calculated as ·23 ampere per gallon per hour; or, taking it in watts, the estimated horse-power required per million gallons in twenty-four hours was 23. The organic matter in solution of the particular sewage acted on on this occasion showed a reduction of 61 per cent. after treatment. The plates, even at half an inch apart, show no signs of blocking. The liquid to be acted on of course should be screened in the usual way and allowed to run through the plates as rapidly as the treatment required will allow, so that every molecule shall come into contact with the surfaces of metal. During a run that lately took place the measurement across the electrodes proved that 19 estimated horse-power was required to treat 1,000,000 gallons in twenty-four hours, the resulting purification of organic matter in solution amounting to an average of 50 per cent., the waste of the iron plates showing an average of two grains per gallon of sewage treated.

In putting down plates for the above quantity of sewage I should allow sufficient weight for five or ten years' consumption; what remained of this could be sold as "old iron" at the end of that time. One of the advantages of having the plates in series is that if anything goes wrong in any particular section it can easily be set right, the current being cut off during the repairs. The shoot containing the electrodes should be coated inside with some sort of asphalte, so as to prevent, as far as possible, any leakage of current to earth, the asphalte acting as a sort of insulator. The highest efficiency would be obtained by using direct driving, provided that the engine is of first-rate workmanship, and the dynamo constructed to run at a comparatively low speed. This saves in transmission, and prevents any difficulty that might arise with belting. Consumption of coal under the best conditions may be taken to range from 1·8 to 2·5lbs. per horse-power hour; the cost of fuel and iron varies so much in different districts, the prices in London being nearly double those near mining localities, that I leave the question of an accurate estimate open. Discounting this, it may be taken that the capital outlay necessary for complete plant, and capable of dealing with the sewage of a small town, amounting to a flow of 1,000,000 gallons daily, would be about £6,000 or £7,000, the engines and dynamos being in duplicate, as I presume most engineers would agree they should be. The quantity of iron plates included in the above sum would be serviceable for ten years, as far as one can foresee, and I am also assuming that the town where this plant would be erected has no appliances for treatment, such as precipitating tanks, &c.; where these are already in existence the cost would naturally be less. In reference to the cost per million gallons the same arguments hold good as to the situation of the town ruling the price. Since my first calculations were made, the rise in the markets has increased the cost of working; but it can be arrived at by the average consumption of iron, and the necessary horse-power. Thus: the daily waste of iron may be taken as 286lb., and the consumption of coal three-fifths of a ton; the labour required for working a plant of this description would be two shifts, two men to each shift.

By combining the treatment of sewage flowing between metal plates with the electric filter, it is possible to produce any degree of purity required. In this case the sewage, after action with the iron electrodes, is allowed to flow into a settling tank, and after remaining there for an hour for the precipitate to subside the effluent is passed through the filter, any oxide of iron that may be present tending to keep the top layer of filtering medium free from any objectionable action, and in turn forming a filtering medium. As the filter consumes no material, and does not require any additional engine power, for in using it the electrolytic action with metal plates not being carried so far, the cost of its working need not be considered. When a sufficient amount of oxide is deposited on the top layer of sand it can be removed, allowed to dry, and sold to gas works. The resulting sludge contains 6 per cent. of iron oxide, which does not represent the waste of the plates alone, for, in London sewage, the wear and tear of the tires of wheels, horses' shoes, &c., in the streets, means oxide of iron in its composition. One sample taken some months back contained no less than six grains iron oxide in the gallon before treatment.

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Sir Henry Roscoe has kindly consented to my quoting a few extracts from his report and the analyses made by him during the investigation of this process. He states:—

"The quantity of sewage operated on in each experiment was about 20,000 gallons."

"The reduction of organic matter in solution is the crucial test of the value of a precipitating agent, for unless the organic matter is reduced, the effluent will putrefy and rapidly become offensive. I have not observed in any of the unfiltered effluents from this process which I have examined any signs of putrefaction, but, on the contrary, a tendency to oxidise."

"The absence of sulphuretted hydrogen in samples of unfiltered effluents which have been kept in stoppered bottles for three weeks is also a fact of importance."

"The settled sewage was not in this condition, as it rapidly underwent decomposition in two or three days even when in contact with air."

"By this process the soluble organic matter is reduced to a condition favourable to the further purification by natural agencies."

TABLE I.—*Sir H. Roscoe's Analyses.*

Percentage Reduction.

No.	Oxygen required to oxidise.	Albumenoid Ammonia
1	67·4	57·0
2	64·3	57·3
3	77·2	75·0
4	72·6	50·0
5	76·5	87·5
6	73·0	87·5

Another series of experiments carried out by Sir H. Roscoe, which I have tabulated (Table I.) show an average reduction of 60 per cent., although the full treatment was not carried out. I have also other lists of analyses by Dr. Meymott Tidy and Mr. Midwinter, which show equally favourable results. I have also tabulated analyses of my own, carried out in 1886, showing the electrolytic action on contaminated canal water (Table II.). Here are analyses (Table III.) of samples taken from each section of the shoot, there being six in series. The organic matter is seen to be gradually reduced by the electro-chemical action. I have never seen an effluent treated in the way described show any signs of secondary decomposition nor develope sulphuretted hydrogen.

TABLE II.—*Canal Water Contaminated with Sewage.*

LABORATORY EXPERIMENTS.

Carbon Plates (Average of 40 Analyses).

	Free Ammonia.	Albumenoid Ammonia.
Before treatment	·073	·037 per gallon.
After „	·053	·014 „

Iron and Carbon Plates (Average Result of 5 Analyses of Sewage).

	Free Ammonia.	Albumenoid Ammonia.
Before treatment	3·0	·431 per gallon.
After „	2·5	·08 „

TABLE III.—*Samples Taken at Different Sections of the Crossness Shoots*

	Oxygen required to oxidise Organic Matter. Parts per 100,000.
Raw sewage No. 1	2·45
Partly treated raw sewage No. 2	2·3
„ „ „ 3	2·15
„ „ „ 4	1·9
„ „ „ 5	1·67
„ „ „ 6	1·51
„ „ „ 7	1·33
Effluent from settling tank, taken while still flowing from the shoot	1·1

The effluent showed no signs of decomposition after a period of 14 days.

In cases where specially prepared or suitable land of a porous nature is procurable the effluent might be wholly or partially used for manuring crops, in which case the sewage should be only so far treated that the prevention of putrefaction is assured.

The advantage of iron in the soil is one which, I think, every practical man must acknowledge. I had some sludge (deposit after electric treatment) pressed without the addition of lime, and it was applied to vegetables, the result being that a marked difference in favour of iron manure was shown in the crops when compared to others grown with ordinary farm-yard manure.

The question of sludge disposal is a difficult one, and, as my Paper is essentially electrical, I will only mention that I should, where practicable, puddle it with chalk, and run on to waste lands, through wooden conduits, similar to the process of mixing clay and chalk in a washing mill, and running into backs, as carried out in cement manufacture, the only alternatives being filter-pressing or shipping out to sea.

The bacteria question is one which has probably still to be settled; but, being anxious to have some information as to the action of the iron compound produced by electro-chemical decomposition, I had some experiments carried out, with the result that after a given treatment the whole of the bacteria were killed. In the case of experiments carried out in Paris, with ordinary treatment by means of iron electrodes, the results were as follows:—

	Raw sewage.	Effluent.
Organisms per cubic centimetre.....	5,000,000	 600

Another experiment, in which the effluent was treated still further, so that a slight odour of oxide of chlorine was perceptible, destroyed all organisms, and the liquid remained sterile.

In conclusion, I submit that the application of the electric current in the several ways I have endeavoured to describe produces a precipitating and oxidising action similar to natural processes, in which the organic matter is destroyed by oxidation due to dissolved oxygen slowly absorbed from the air, assisted in many cases by matters in the soil, such as oxides of iron, acting as carriers of oxygen, and I also consider that the question of cost will bear favourable comparison with any process which really does the work attributed to it.

Mr. SHOOLBRED said he had seen a number of experiments carried on at St. Albans. Mr. Webster had alluded to the use of cast-iron electrodes in the treatment of sewage. There were cases when wrought iron might be used with advantage. In this scheme there was really something that was well worth consideration by sewage authorities. It was a most important question for towns. The problem might be looked at in the broad light of saving the enormous amount of chemicals, principally in the form of chalk and lime, which had to be bought at considerable expense, and then the sludge itself had to be removed at still more cost to the town. It was a question whether this immense amount might not be saved to a very large extent by the expenditure of a certain sum on coal for driving certain engines to produce the electric current. The experiments certainly pointed to the fact that the whole system was well worth the consideration of the authorities of those towns where admittedly the sewage question was one of daily and hourly increasing burden as well as importance.

The PRESIDENT (Mr. William Anderson) said he was extremely glad the Paper had been written, because it put in a definite manner on the highest authority a statement about which rumours had been floating for two or three years. He thought there was a hope that this process would be, at any rate, one of the solutions of the great sewage question

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MR. BOY'S METHOD OF SUSPENSION BY QUARTZ FIBRES.—PRACTICAL HINTS.

We make the following extract from Mr. Vernon Boy's recent Cantor Lectures, which are now appearing in the *Journal* of the Society of Arts:—

The following hints may be of use to those who are going to mount apparatus upon fibres for the first time:—Having chosen a fibre of the right diameter, and longer than is ultimately required, the first thing to do is to fasten a small fragment of gummed stamp paper to one end. This acts as a weight, and makes the following processes more easy. The upper or fixed support must next be fastened to the free end of the fibre. I prefer a common blanket pin passing through a cork to any of the more elaborate contrivances in common use; however, whatever is going to be used for the fixed support should be pointed at the lower end.

If the needle or other thing to be supported is very light, *i.e.*, nowhere approaching the breaking weight of the fibre, shellac var-

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nish is the best thing to use as the cement. Just moisten the last five millimetres above the pin with this varnish, and—holding the fibre near its free end in one hand, and the pin in the other, with the little finger of one hand resting against the little finger of the other, for the sake of steadiness—immediately apply the fibre to the varnished surface, to which it will stick. Then pull it endways through a distance of half a millimetre about, to make sure that when all is dry there will be no sudden bend in the fibre. A hot piece of wire, or knife, or pair of pliers must then be applied to the pin above the varnish, so that the heat may be conducted down slowly to drive off the remaining alcohol and melt the shellac. After this the fibre is securely held at that end.

If the thing to be supported is very heavy, varnish is not so good as melted shellac, but this is much more difficult to apply. The pin must be warmed and smeared near the joint, and while hot the fibre must be applied and slightly pulled. Whether varnish or melted shellac is used, it is essential to work in a proper light. A table in front of a large window in the day, or supporting one or two movable gas burners at night, will do perfectly provided that a really black background exists, upon which the fibre may be made evident. Black velvet, or paint, or paper is no use whatever. The only background that does well, and one that is easily arranged, is the darkness inside a drawer just pulled out an inch or two.

Assuming that one end of the fibre is properly fastened, the next thing is to determine the exact length required. For this purpose I always make a drawing on a perfectly clean and smooth board, showing the point of the pin at one end, the extreme end of the thing to be supported, and the position of the mirror or whatever determines the length of the fibre.

The holding-pin is then raised up until the paper weight is hanging in the air. This is then allowed to rest on the board, and slowly dragged along until the point of the pin is exactly over the corresponding mark on the board, and the paper wafer is in the line of, but beyond, the other mark. The fibre is then straight, and must pass over the mark which indicates the upper end of the apparatus that is to be suspended, though, of course, nothing can be seen. A knife is then drawn across the board, say five millimetres beyond this mark. By this means the fibre is cut, and the five millimetres are left for the purpose of attachment. The needle or suspended thing is then fastened in the same way as the pin. It is well then to drag the needle along until the mirror is exactly over its place on the drawing, and see if the upper pin is also in its place. By warming either pin, and pulling the fibre, a slight alteration can be made if necessary.

The paper weight with the remainder of the fibre may then be taken up, and the free end fastened on a microscope slide and labelled, so that the diameter of the fibre may at any time be found. If the fibre, illuminated by a distant light, had been examined with a prism first, and the dark bands of the spectrum had been found straight and uniform from one end to the other, and it is only such fibres that I use, then the diameter must be the same over the whole length.

THE THOMSON ELECTRIC WELDING PROCESS.*

BY W. C. FISH.

The art of electric welding was first brought into application by Prof. Elihu Thomson, who had the questionable misfortune of accidentally short-circuiting an induction coil, which resulted in the fusion of the copper wire of the coil. Professor Thomson first publicly exhibited this process in New York in 1887, and it is now among the growing applications of electric energy. The electric weld was generally made by the passage of a suitable current through the pieces to be welded, combined with the application of pressure forcing the pieces together. The different fluxes employed in the electric process are similar to those used in the ordinary methods of welding. By the electric welding process it is possible to unite most commercial and precious metals and alloys and several combinations of different metals and alloys. Most of these substances have hitherto been unweldable by other processes, chiefly owing to the inability to nicely regulate the supply of heat to the weld, and to the impurities existing in the forge fire and other commercial sources of heat. The process can be used in those places where a forge fire would be a source of annoyance or danger. The nicety and certainty of the work is obtained chiefly through the cleanliness of the heat employed, and also because the pieces to be welded are held in correct relative position during the entire operation.

Discussion.

Mr. ALEX. SIEMENS confirmed the general results of the paper, remarking that they had made joints for strengthening wires by electric welding when their firm took out an Atlantic cable 12 years ago.

The PRESIDENT said the process would be of enormous value if they were able to weld finished work without destruction. The welding of boilers for instance, and the welding of rivets *in situ* would be a great gain.

* Abstract of Paper read before the Iron and Steel Institute, in Paris, September, 1889.

THE ELECTRIC LIGHT AT PADDINGTON.

SPECIAL MEETING OF THE VESTRY.

The adjourned special meeting of the Paddington Vestry was resumed yesterday. The discussion was resumed on the following motion, proposed by Mr. Mark H. Judge, seconded by Mr. W. H. Mills, and carried as an amendment to Mr. Minchin's motion :—

"*That inasmuch as the Electric Lighting Committee has not seen its way to recommend the Vestry itself to undertake to provide electricity for lighting and other purposes in the Borough, it is desirable that steps be now taken to secure it being done at an early date by private enterprise under a Provisional Order approved by the Vestry as the Local Authority.*"

Mr. LEE moved the following amendment :—

"*That the whole question of electric lighting in Paddington be referred to eleven members to form a Special Committee.*"

During the last two or three years the question of public lighting by electricity had made rapid strides. Eleven companies had laid down wires over various parts of London, and three millions had been invested in the various undertakings ; it was, therefore, absurd to speak of the Vestry speculating with the ratepayers' money. He advocated the undertaking being left in the hands of the Vestry. The opinions of two experts had been obtained at a cost of £150, yet the Electric Lighting Committee had reported against their opinions without giving any reasons. He asked the Vestry to refer the matter to a Special Committee, and not tie their hands by passing Mr. Judge's resolution.

Mr. MINCHIN pressed the Vestry to do the work themselves. When he proposed last week a loan of £50,000 being raised it was not proposed to spend it all at once—£25,000 would probably suffice, and as more applications were made for the light more capital would be employed.

Mr. M. H. JUDGE then asked the Vestry to agree to his resolution. He said it was impossible to get a Provisional Order by 1890. He was of opinion that the whole of Paddington should be supplied with the electric light, but this of course was conditional. If certain districts did not apply for it, of course they would not have it.

Mr. LEE then withdrew his amendment, and Mr. Judge's resolution was put as a substantive motion, and after a little discussion was passed unanimously, as was also his further motion that it be referred to an Electric Light Committee of 11 members to prepare a draft Provisional Order by making such modifications in, and additions to, the latest Model Order issued by the Board of Trade as they deem necessary. The following 11 gentlemen now form the Committee : Colonel Barchard, Colonel Blair, R.E., Mr. W. Clarke, Mr. Jephson, Mr. Mark H. Judge, Mr. Maberly, Mr. W. H. Mills, Mr. Minchin, Mr. Williams, Mr. Stephenson, and Mr. Chapman.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September* 21, 1889.

The chief event of last week was the meeting of the National Telephone Association at Minneapolis, when the eleventh Convention of that body was held under very pleasant auspices. The one thing that occurred to mar the enjoyment of the occasion was the display of the determination on the part of several of the members not to have the proceedings made public. This was very much against the desire of other members, and very much to the annoyance of the electrical journalists, some of whom had spent a large sum of money and travelled 1,500 miles in order to be present and to participate. I believe I hinted last week at something of this nature being probable. The fact is that, as the term of the controlling patents runs out, the telephonists now commanding the situation become more and more apprehensive as to business competition, and less and less desirous of spreading information which may be of any benefit to their coming rivals. On the other hand, the fact that the Convention wishes to sit with closed doors makes many curious people resolute to find out what was actually done, and arouses various suspicions in the minds of

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the public, which in this country, at least, is not at all inclined to look with a kindly eye upon anything like monopoly. The upshot of the affair was that the Convention excluded members of the Press, but furnished them with copies of the Papers read. In regard to one of these Papers, that on long-distance telephony, it seems to have been the desire of the Executive Committee, for some reason or other, that it should not be printed, but so far as the wishes of the authors could be ascertained, it is said they were very much in favour of publishing the Paper on which they had bestowed so much time, and hence the newspapers have taken the bull by the horns and printed the Paper. It is, of course, hard to please both parties in such a case as that, and perhaps the best and only thing to be done is to print the Paper, which seems to be a valuable and inoffensive addition to the literature of telephony. No stenographic report of the discussion was furnished to the papers, although this does not appear to have been a very severe loss, but in respect to the banquet the Executive Committee very kindly relaxed their harsh rule, and handed out to the papers a full and overflowing report of their post-prandial eloquence.

The Paper dealing with long-distance telephony was written by Mr. A. S. Hibbard, J. J. Carty, and F. A. Pickernel, three of the brightest young telephone engineers that we have. It enters very fully into details of long-distance work and the construction of metallic circuits, and discusses also the various changes that may be necessary in order to bring the local telephony into scientific and harmonious adjustment to the new long-distance business, which is becoming rapidly a very important factor in the transmission of intelligence all over the country. An interesting little Paper was read by Mr. R. M. Bailey on the subject of telephone salutation, in which he objected to the universal "Hello," and suggested that some form of introductory remark more suave and polite might be adopted. He pointed out that there was altogether too much "helloing," which took up time and did not by any means assist the coming together of the two parties anxious to begin talking, and he also criticised the excessive ringing of call bells, which is very much of an annoyance in offices where telephones are placed. Mr. E. H. McFall, of New Orleans, presented a pithy little Paper on the subject of the interference with the telephone circuits in New Orleans by the alternating-current circuits put in operation there. Mr. McFall did not state it in his Paper, but I believe the subject has become a matter of litigation. Mr. McFall says that the humming over the telephone circuits resulting from the interference is as strong and vigorous as ever, although various remedies have been tried. Several other members of the Association are suffering in the same way. In some places a compromise has been resorted to as to the bearing the expense of making the telephone circuits metallic, or in taking the heavy current wires along some other route; but in several instances, as for example in Cincinnati, there is litigation over the subject. In a great many of the larger cities it is only a question of time with the telephone companies as to the adoption of the metallic circuits reducing these injurious extraneous influences to a minimum, but in many of the smaller communities there will be trouble, unless the various companies giving the different services can come to some kind of amicable arrangement on the subject. Mr. W. D. Sargent, who has been elected President of the Association for the current year, read a brief Paper on the telephone exhibit at Paris, embodying a few observations on what he had seen in Europe while in charge of the Bell Telephone exhibit at Paris, and stating his impression that we have little or nothing to learn from abroad with regard to the operation of the telephone, or the carrying out of underground work. With regard to London, Mr. Sargent stated that he found the telephone system there to be entirely overhead, and that in Trafalgar-square he saw a large lead cable stretched along one side of the square in full view from all points. A report of a statistical nature, presented by General C. H. Barney, the Secretary, stated on this point that out of 48 exchanges reporting only eight have had experience in underground work, namely, New York, Brooklyn, Boston, Detroit, Pittsburgh, Buffalo, Washington and Louisville. New York City has the longest underground conductor, one over five miles in length, and has the greatest mileage of underground wire, 7,034 miles. The exchange at Pittsburgh claims to have had conductors working successfully underground since they were first laid there, seven years ago. A few other statistics from this report of General Barney are interesting. Thus, Boston, for instance, shows a gain of 48 per cent. in the number of subscribers last year, running up from 2,288 to 3,386. The average gain of the exchanges is about 8½ per cent. Grand Rapids has one subscriber to every 27 inhabitants, Portland, Oregon, has 1 to every 30, Providence 1 to every 49, New Orleans 1 to 188, Brooklyn 1 to 220, and Philadelphia 1 to every 309. Some of these subscribers manage to get the worth of their money out of the exchange, as, for example, at Richmond, where the average is 17·01 calls per subscriber per day. Atlanta, Ga., has nearly as many with 14·3. New York has only 7·8, while San Francisco actually reports only 1·6. It appears that in the majority of the exchanges the operators are busier this year than they were last, and several of them show a slightly increased cost per connection. It may be interesting to some of your readers to know that in 47 exchanges, with 1,435 operators, the highest average salary, including the chief operator, is £5 per week, the lowest is 18s. 9d., and the average is 23s. 9d. In 47 exchanges with 268 men, the average daily pay for linemen is 8s. 3½d., and for instrument men 7s. 6d., and for "combination" men 8s. 2d. I presume that these rates compare favourably with those paid in England, and they are pretty good pay, although in no instance will they lead to the rapid accumulation of wealth.

We have been following in this country with considerable interest the movements of Mr. Edison in Europe, and it has been a matter of gratification to everybody to witness the honours paid to him. It is felt that these honours are paid not simply to Mr. Edison as a great inventor, but to him also in his typical and representative character; and every such compliment adds, therefore, to the links of friendliness and esteem between America and Europe. It is believed in some circles here that Mr. Edison is contriving, in the intervals of sightseeing and being seen, to pay a little attention to business, and on this point the correspondent of the *Boston Herald* in London sent over the following curious piece of information, which I cannot do better than give you in full. You will probably be better able to judge of its worth than we are, and as to whether England would care to enforce with any colony any special reserve right except for weighty reasons:—"Frank Upton, president of the Edison Electric Lamp Company, at East Newark, and Eugene H. Lewis, of New York, who were with the Edison Party in Paris, arrived in London this week, and Upton sailed on the 'Saale' Thursday. Lewis, who is Edison's lawyer, and has conducted most of his recent patent suits, remains here to meet Edison and Evarts, a circumstance showing that Edison has changed his plans, and will come to London, and that he is to be accompanied by Mr. Evarts, whose ostensible purpose in visiting Paris was to have his eyes treated by an eminent French oculist. This gives rise to a rumour affecting electric lighting interests in America. The rumour is that Edison and the two lawyers visited London for the purpose of having a consultation with Her Majesty's Ministers about the prospect of Canada being included in the Patent Convention of 1883, which governs the patent laws of the United States and Great Britain, with a view to its effect upon Edison's high-resistance filament patent now in litigation in Canada. England reserves the right by the terms of this Convention to include any of her colonies under its provisions, and the clause that is supposed to interest the Edison people provides that the importation of a patented article from one of the States bound by the Convention to another shall not invalidate the patent. The filament patent was first taken out in Canada, and according to Canadian law an article patented in that country and manufactured in another country cannot be imported into Canada without invalidating the patent. Whether the Edison filament patent has been thus invalidated is now being considered in the Canadian Courts, and the representatives of other American electric lighting companies who will be affected by the decision believe that an effort is to be made to bring Canada into the

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Convention that binds Great Britain in order to take advantage of the clause giving the right of importation between the States bound by the Convention. This would, at least, give an opportunity to gain time by bringing an intricate legal question into the Courts. Lewis professes utter ignorance of any such move on the part of Edison and Evarts, however." In the meantime, it may be stated, that the Edison people are pushing their business very successfully and vigorously in Canada, and that they are greatly increasing their facilities for manufacturing their apparatus in the Dominion.

An interesting description has just been published of the Hall electrolytic process for the production of aluminum now being carried out by the Pittsburgh, Pa., Reduction Company. The process is a direct one, and consists of the electrolysis of the oxide alumina from which the metal is produced pure in one operation, when all that is necessary to render the metal ready for sale is re-melting and casting. A fused bath is employed consisting of metallic fluorides which are less easily decomposed than aluminum, and have a lower specific gravity than the reduced metal, which sinks to the bottom of the bath, and is thus prevented from re-oxidation. The ore, or alumina, is dissolved in this bath, being decomposed by a low volt current, the oxygen going to the positive pole, and the aluminum to the negative. The current serves also to keep the bath melted. Each of the two pots in which the reducing operation is now carried on is about 24in. square and 20in. high, and is heavily lined with gas carbon. The pots are connected in series; each takes from 8 to 10 volts, being fed with current from two large dynamos developing 20 volts and 1,800 amperes, and contains a fused bath of from 200 to 300 pounds of the electrolyte. Three-inch carbon cylinders form the positive electrodes, and the gas carbon lining forms the negative. From each of the pots, as thus constructed and operated, a pound of metal per hour is obtained, and the ore is added in small quantities as required, so that the process may be kept up continuously day and night without interruption. A modification of this process has been worked out for the manufacture of aluminum bronze, in which with the same bath the electrodes, instead of being of carbon, are of copper. One of the great recommendations of this Hall process is that it is direct, and the claim is made for it that it is comparatively very cheap, while the product is excellent in its purity.

I have already given you sundry notes with regard to the late meeting of the American Association for the Advancement of Science at Toronto. I may now add, as of interest, that a Paper was presented by Prof. G. F. Barker, of Philadelphia, on a new form of storage battery. It is a zinc peroxide of lead battery, which is said to have been under test for the last two years, and which promises good results. The negative plate is composed of well amalgamated zinc and copper riveted together. No E.M.F. is set up between two such amalgamated plates. The positive plate is built up of a large number of thin lead plates covered with graphite, and riveted together with lead rivets about an inch apart. The compound plate is then perforated with numerous small holes. The graphite keeps the plate apart, and allows the solution to penetrate into every portion, so as to reach the entire lead surface. The electrolyte is an acid solution of zinc sulphate. No active matter in the form of lead oxides is applied to either plate; but the positive is strictly a Planté plate of very large surface. During the charging process the positive is peroxidised, and metallic zinc of a beautiful crystallised appearance is deposited upon the negative. These cells show an enormous increase in storage capacity per pound of metal, as compared with cells of the Faure type. A table of comparisons with several other cells was given, which exhibited the superior storage capacity of this new claimant. The new cell permits any rate of charging and discharging, and is exempt from the usual dangers of sulphating; in fact, in this respect it resembles the original Planté, which is much less liable to suffer from rapid discharge or from exhaustion than the Faure form.

The American Institute of American Engineers has resumed its meetings, and the first Paper of the present season was read last week by Lieut. F. J. Patten, U.S.A., on the subject of alternating-current motors. This has been his special work for some time past, and he certainly seems to be securing some decided advance in the direction of the utilisation of power transmitted long distances by the alternating current. The new motor which he described is self-starting. It is at first similar to an ordinary continuous-current motor on an alternating circuit. When the synchronism is attained, although a true alternating current flows, it traverses the two parallel circuits of the armature always in the same direction, maintaining constant polarity, this end being attained by a very simple method of armature connection. The re-directed current is also caused to traverse the field current. The Paper was subjected to a lively discussion, but the pith of the criticism was that Lieut. Patten made a distinct advance in a direction different from that in which Mr. Tesla and others have been working, and one which may lead to very desirable results. One of the objections advanced was that the consumer might find himself exposed to the danger of the high-tension current in the main wire, but, of course, if this objection holds it would apply also to series motors on arc circuits, and we have a great many such motors operating safely and successfully in this country. Some of the members seemed to think that it was best to strive for a motor without commutator or brush, but Lieut. Patten succeeded in convincing his audience that there were other features worthy of consideration.

CORRESPONDENCE.

THE DEFINITION OF IMPEDANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just seen in your issue of September 20th, page 486, a statement with regard to the Resolutions of the recent Paris Electrical Congress, as modified by the Electrical Standards Committee of the British Association, which calls for a correction from myself. The Committee have adopted the term "impedance" instead of "resistance apparante." The term "resistance fictive," mentioned in your Note does not, I think, occur in the resolutions agreed to at the full sitting of the Congress on August 31. The term "impedance" is defined by us in exactly the same way as "resistance apparante" in the French resolutions; it is the ratio of the effective electro-motive force to the effective current, so that, in symbols, impedance

$$= \frac{\sqrt{\frac{1}{T}\int_0^T E^2 dt}}{\sqrt{\frac{1}{T}\int_0^T i^2 dt}}.$$

In the case of a simple harmonic electromotive force of frequency $n/2\pi$, the right hand side takes the well-known form $\sqrt{\{R^2 + L^2 n^2\}}$, but the term impedance is not defined by this expression, as would appear from your Note, but by the more general one above.

I hope to send you shortly a copy of the report of the Committee, which is at present in the hands of the printer.—Yours, &c.,

R. T. GLAZEBROOK,
Secretary Electrical Standards Committee.

Cambridge, Oct. 1, 1889.

[We are glad to have this correction; but in justice to ourselves we must add that our attention was especially called by a member of the Committee to the alleged difference of definition to which we referred in our Note.—ED. *E.*]

IRISH'S ELECTRIC PRINTER FOR NEWSPAPERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of the 6th instant first to hand an editorial having reference to the Electric Printing Telegraph of Mr. H. T. Higgins and Messrs. Wright and Moore. Permit me in fairness to Mr. W. E. Irish to call your attention to the

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enclosed description of his "Column Type Printing Telegraph," which was published early in 1883, five years prior to the invention by Messrs. Higgins, Wright and Moore. The printed matter is from a catalogue published by Weedon and Irish in 1883 or 1884. The same machine is mentioned by the *Railway Supplies Journal*, May 1, 1885.

These facts may be the means of preventing the threatened litigation you refer to between the more recent inventors of the "Column Type Printing Telegraph."—Yours, &c.,

Cleveland, Ohio, Sept. 18, 1889. W. M. MONROE.

[COPY.]

"This apparatus and machinery consists of a keyboard having keys representing two alphabets, with the necessary numerals and punctuation signs; a cylinder for carrying the paper upon which the first impressions are made, and a clockwork for propelling the cylinder, and another clockwork for actuating the communicator. A reporter seated with the above apparatus and his manuscript before him manipulates the keys and *prints the matter upon the paper, which is the width of a column of the paper he represents. When the columns are thus printed, they are by the compositors secured in order to an iron or stone slab* the size of the newspaper to be printed, and representing any number of pages. On the printing roller being passed over the printed paper the ink leaves the paper, having affinity for the roller, upon which it sets hard. The inker now passed over the originally printed paper leaves ink only where the paper had previously been printed upon, from which another printing roller takes the matter; thus a second and a third impression may be obtained as previously described upon rollers in duplicate. Two printing rollers, each representing one side of the paper, are now caused to revolve one beside the other with inkers revolving upon them. Between the printing rollers sheets or a continuous ribbon of paper the width required is passed, so that every revolution a paper is printed and severed from the ribbon, where such is used, and falling into a receptacle comes out a folded printed paper. For the printed matter transferred to the rollers in the first instance a specially prepared ink is employed. This ink leaves the paper freely for the printing roller, on which it quickly dries and sets hard. This hard ink type takes up ink freely from the inkers, but the other portion of the printing rollers rejects it. By means of this apparatus a newspaper may be printed in one quarter the time now occupied with one third the staff. The type wheels, which have various forms of type, are interchangeable, so that any description of printing may be done by one machine.

[We print our correspondent's communication in full, as it reaches us, but for our own part we fail entirely to see what possible bearing Mr. Irish's invention, so far as it is here described, can have upon the invention of Mr. Higgins or of Messrs. Wright and Moore. Mr. Irish seems to have had a totally different object in view.—ED. *E.*]

PROF. PERRY'S VOLTMETER.

TO THE EDITOR OF THE ELECTRICIAN.

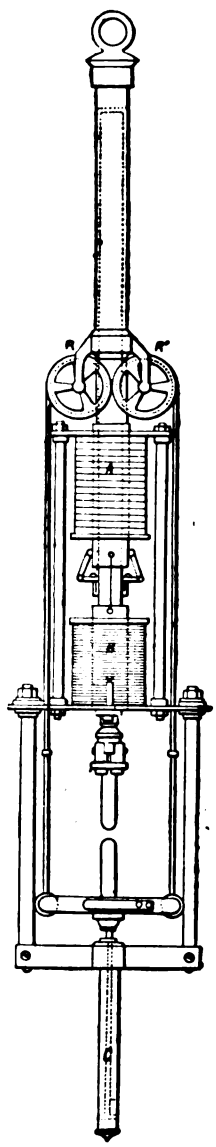
SIR: I was as much interested and surprised a short time ago as Mr. Evershed evidently now is to hear that Prof. Perry had devised, and succeeded in perfecting, a voltmeter on precisely the same lines that Mr. Evershed and I constructed one three years ago. We gave it up, as Mr. Evershed has said, on account of the excessive power which seemed necessary to work it. Prof. Perry was kind enough, a month or two ago, to show me his instrument, which it certainly seems he has succeeded in making into a very good voltmeter. By using a very thin and narrow strip of platinum silver only a few inches in length, with a wire resistance in series with it, he has produced an instrument which, so far from taking forty amperes to work it, does not take any more power than an ordinary Cardew voltmeter. Prof. Perry also finds that he can artificially "tire" the spring so that it will always, though slowly, return to zero. I believe, however, that some difficulty may occur in compensating the spring—especially when made of carbon—for variations in external temperature. The use of such a spring is evidently not confined to voltmeters. Prof. Perry has a weighing machine constructed with one. The motion of the spring is very pretty, and no doubt "vastly simple," but all the same I believe the mathematics of it have not yet been discovered.—Yours, &c.,

Oct. 2, 1889. GILBERT S. RAM.

THE KREMENESTSKY ARC LAMP.*

The Kremenestsky lamp consists of two solenoids, A and B, wound respectively with thick and thin wire; two soft iron cores connected by levers, as shown; two rods serving as guides to the negative carbon holder, which is supported by two cords wound round the pulleys R R'; an air dash pot, C.

If the lamp is switched into circuit with the carbons in contact, the solenoid A attracts its core, pushing up the positive carbon holder, thus striking the arc. When the lengthening of the arc increases the action of the solenoid B, the lower core is sucked downwards, the levers extend, and the positive carbon descends, causing the negative carbon at the same time to rise. The arc diminishing, the action of A again preponderates, and so on.



This lamp does not work as regularly as the Pilsen, because the equilibrium between the counter weights and the solenoidal attractions is not exactly realised in every position of the rods.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

September 20, 1889.

14,814. W. H. GRITTON. London. The making and construction of a panoramic electric lighted automatic advertiser.

14 815. W. H. GRITTON. London. The making or construction of electrical covered angle, sunk, reflective or other letters or signs used for facias, words, names and advertising generally, to be made in any suitable material.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Électricité," by kind permission of the author.

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September 24, 1889.

15,028. W. B. Sayers. London. Regulating mechanism for arc lamps.

15,044. J. H. Smith. Broughton-in-Furness. The automatic ringing of a bell or gong at any single-needle telegraph station when that particular station's code is given.

14,860. G. H. Hoffman. London. Improvements in automatic telephone devices.

14,871. E. Hopkinson and D. Appleton. London. Improvements connected with or applicable to baths or vessels containing liquids used in electro-plating or dyeing, or the electrolyte of storage batteries and the like.

September 21, 1889.

14,894. T. Parker. Wolverhampton. Improved furnace and apparatus for electro-chemical and chemical manufactures.

14,932. A. Friedlander. London. A combined cigar-cutter and electric lighting device.

September 23, 1889.

14,953. M. J. Kenny and G. Barry. Waterford. The application of the electric bell to the knockers of hall doors of hotels, hospitals, public institutions, and those of medical and clerical gentlemen, by a special process.

14,971. P. J. R. Dujardin. London. Improvements in secondary batteries.

14,991. O. T. Bláthy. London. An electricity meter for alternating currents.

SPECIFICATIONS PUBLISHED.

1888.

12,609. Thompson (Lémonon). Electrical locks. (Price 8d.)

14,963. Cox-Walker and Swinton. Electric bells, &c. (Price 11d.)

15,206. Brown. Transmitting telegraph, &c., signals. (Price 8d.)

15,433. Handford (Duncan). Secondary batteries. (Price 8d.)

15,877. Rousseau. Secondary batteries. (Price 8d.)

15,921. Siemens. Electric railway signals. (Price 8d.)

18,718. May. Telegraph, &c., posts. (Price 6d.)

1889.

8,657. Bright and others. Conducting, &c., electric currents. (Price 8d.)

11,927. Pitt (Atherton). Covering electrical conductors. (Price 8d.)

12,402. Kookogey. Galvanic battery solution. (Price 4d.)

COMPANIES' MEETINGS & REPORTS.

The Direct Spanish Telegraph Company.

The thirty-second ordinary general meeting of the Company was held at Winchester House, Old Broad-street, under the presidency of Sir James Anderson.

The MANAGER (Mr. C. Gerhardi) read the notice convening the meeting and the minutes of the last ordinary general meeting, which were confirmed as correctly entered. The report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, I think you will regard the report as, on the whole, fairly satisfactory. There is a decided increase in our traffic—£508—and a slight decrease in working expenses, perhaps not worth mentioning, but still it is a decrease, and with an increase of traffic and a decrease of expenses no one can find fault. As you know, we had in the half-year to which the report refers an interruption of sixteen days of the Bilbao cable, but, fortunately, we have a joint purse arrangement with the Eastern Telegraph Company, and the losses of traffic by these interruptions are never very serious. I am glad to say that our revenue is mainly due to commerce. There were no political disturbances of any kind that gave us any telegrams. We find, on looking into matters, that many towns in the United Kingdom which now have a very free intercourse with Spain by telegraph never used the telegraph a few years ago, and therefore, I suppose, they had no trade with Spain. We are led to believe, or to suppose, that the trade of our country has increased with Spain, and that must be matter of general congratulation to us all. Last month alone we carried 2,920 more telegrams and 31,200 words in excess of the number carried in September last year; and for the past quarter—July, August, and September—our receipts were £381 in excess of those of last year, notwithstanding our low tariff. I suppose you all know that our tariff is very low—4½d a word. We deliver our messages in Bilbao under ten minutes—very often in five minutes; and in Madrid they are delivered a good deal within the hour—I am told three-quarters of an hour, and we hope to improve that. All telegraphic service depends, first on accuracy, and then on speed, and we are increasing the speed as far as we can, getting better wires from Bilbao to Madrid and Barcelona. So far as Madrid is concerned we have very little to complain of—in fact, we do not complain, but still there is room for improvement. We have still to count with the reduction of the length of the messages, and I scarcely know where this is going to stop. The reduction has been going on at the rate of nearly a word every year. I do all I can to persuade myself—I hope justly—that though the length of the messages decreases their number increases. I saw just now that last year I told you, as I did the year before, that though we carried more messages we made less money; but we have now got over that, because this year we have made more money and carried more messages. Therefore, I hope it is fair to infer that the reduction in the length of the messages has come to a stop, and that that being so we shall get more revenue. The only thing I have to call attention to in the way of expenditure since the expiration of the half-year of which I have been speaking is that we have removed our London Telegraph Station from Leadenhall-street. Owing to the increase of our business we became very crowded there, and we have taken larger offices in Gracechurch-street. The cost of this removal, not including the shifting of the pneumatic tube, we estimate at about £600. We propose, however, to take that amount from revenue gradually, and not to add it to capital. I have now told you all that is worth telling. The report is very simple, and I think that a small report and a big dividend is about as good a combination as a shareholder in any company can have. I now propose,

"*That the report and accounts now presented be and are hereby received and adopted.*"

Mr. EDMUND ETLINGER seconded the motion.

The CHAIRMAN: If any gentleman has any question to ask I shall be glad to answer him.

Mr. COCHRAN inquired the meaning of the entry in the balance-sheet—suspense account, £260. 14s. 10d.; and he also desired to know what difference in the rent the change in the offices would cause.

The CHAIRMAN: About £80 a year. The suspense account is mostly composed of items expended on account of the removal, but not appertaining to last half-year. The rent is higher because the premises are more important. We put up formerly with very small premises. He put the motion, which was carried unanimously. Continuing, he proposed the following resolution:—

"*That the dividend at the rate of 10 per cent. per annum, less income tax, on the Preference Shares, and a dividend at the rate of 5 per cent. per annum, free of income tax, on the Ordinary Shares, both for the half-year ended 30th June, 1889, be, and are hereby declared.*"

Mr. ETLINGER seconded the motion, which was carried unanimously.

The CHAIRMAN having intimated that that closed the business of the meeting,

Mr. COCHRAN proposed a vote of thanks to the Chairman and Directors for their conduct of the Company's affairs, the general result being, he thought, eminently satisfactory.

Mr. LOWE seconded the motion, which was carried unanimously.

The CHAIRMAN: I am very much obliged to you for the confidence you have expressed in my colleagues and myself. We have not a long story to tell about hard work, and we have not had much of that in the past half-year. Still, the traffic requires looking after, or it would slip away elsewhere, and it is necessary that the Company's officials should steadily look it up. I hope it will be a long time before I have to make a long speech to you, as that generally means an interruption of the cable or something we do not like.

The proceedings then terminated.

Electric Construction Corporation.

The first ordinary (statutory) meeting of the Electric Construction Corporation (Limited), was held on Friday last, at the offices of the Corporation, Worcester House, Walbrook, Sir Douglas Fox, J.P., presided.

The SECRETARY (Mr. F. Walton) having read the notice convening the meeting,

The CHAIRMAN said—Gentlemen, as you are aware, this is our statutory meeting; therefore we have no report to present to you, nor are there any resolutions to be proposed; but I need hardly say that it is a great pleasure to the Directors on this, the first occasion, to be able to meet the shareholders face to face, and to exchange a few ideas with reference to the present position, and the possible future of what we believe to be a most important Corporation. I may say, to begin with, it is perhaps a most important point—that all our capital was fully subscribed, and I do not think you could easily find a company of this size whose capital is more strongly held than ours is at this moment. Another point, which is very important, is that our works are fully occupied. We have as many orders as we can execute, and we could easily have a great many more if we could only execute them. I think, as you look at the gentlemen on my right hand and on my left, you will feel that there are practical men amongst us, and we are naturally inclined to be cautious in what we do; at the same time, our chief difficulty at this moment is that we have not room enough in our works to enable us to extend our business as we should wish. The consequence is that the first attention of your Directors has been given during the few months which have elapsed since this Company was formed to laying out very carefully and preparing to immediately erect extensions of our works at Wolverhampton. I am glad to say that, by the assistance of the gentlemen who are thoroughly well acquainted with Wolverhampton, and who have given an immense deal of time to this matter, we have been able to secure an excellent site there, with good railway and canal communication, ample not only to provide for a very large extension of our business at the present moment, but also to provide for the future. Upon that site we intend immediately to erect works which will enable us to very largely increase our output at Wolverhampton. I am very glad to tell you also that in connection with the accumulator business of the Electrical Power Storage Company there is a steady growth, and when we are able to combine all the business, as we intend to do, in this office, and to have all our arrangements at headquarters, you will see that that will form a most valuable adjunct to the general business of the Company. It is not very often, especially at this time of the year, that we get such a good attendance of shareholders at a statutory meeting, but we were rather anxious that our shareholders should meet us in our own offices on the first occasion, rather than that we should

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go to some hotel, and if the room is rather crowded perhaps you will excuse us. You will probably be aware that we are engaged at the present moment in supplying a very large quantity of plant to one of the most important companies that is supplying this metropolis. I think you will be interested to hear that Mr. Edison, who has just had an opportunity of visiting one of the installations with which we have had to do in this metropolis—namely, Rathbone-place—was pleased to say that it was the most satisfactory place he had seen during his visit here, and I am quite sure that the high character which our Works' Director at Wolverhampton has secured to us by the excellent work he has been able to turn out will be a most important factor in the success of this company, if only we can provide him with works large enough and with sufficient means to enable him to execute the orders which are pressing upon us on every side. Then, with reference to provincial questions, I do not think it would be wise—and I am sure the shareholders will agree with me in this—to mention names at the present time, because our business in that direction is somewhat in a preliminary stage. We are carrying on very active negotiations with several most important towns, both with reference to lighting, in which, I think, this Company is going to fill a very important position, as being able not merely to provide these towns with light, but to help in the financial arrangements connected with lighting. I think that is where we are going to have a very important sphere of business; and then not only with reference to lighting, but also with reference to the application of motors to tramways. We have got several very important matters before us, and we hope that before long we shall be able to show our shareholders a practical installation of this kind, where we shall be able to run the tramways by electricity in the very successful way in which they are being run so largely in the United States. We have applications both with reference to our Julien patents and to our Sprague patents. Then I may also say that with reference to the third point to which we attach importance—that of the installation for train lighting—a very excellent example has just been carried out by the Midland Railway Company upon the Stroudley-Houghton principle, and I believe that although it is only just started, it is likely to be a very great success. The great difficulty which has arisen with reference to train installations has been how to replace the power, and I think the arrangements which are being made in connection with this train on the Midland are very likely to solve that difficulty. The great requirement for railway installations is that we should be able to light a train and be able to break it up. That has been done successfully on the Brighton Railway, but what we want is to light the train and be able to take a carriage off and shunt it on to a branch line. I do not know that I have anything more to say to you to-day, gentlemen. If there is any question any shareholder would like to ask I will endeavour to answer it to the best of my ability. Our difficulty at the present moment is simply this—that our works are quite insufficient to deal with the orders which we can secure at once, and therefore we are obliged to proceed rather cautiously; at the same time, I think we are laying the foundation of an excellent business. I may say we have secured here offices which will not be at all too large for our purpose, and we hope you will consider that they are in a good central position. And in connection with these offices we intend to have a thorough good arrangement in the base where our various manufactures will be placed so that intending purchasers, and those in this city who intend to adopt electricity, will be able to come and see exactly what we are prepared to give them. It has been found very important to do this in connection with the Electrical Power Storage Company, from which we believe we shall secure a good deal of support. Before long we shall have a general meeting, and then we shall hope to present a regular report. In the meantime I must ask you to be content with this very lame attempt to explain to you exactly how we stand.

A SHAREHOLDER: Do we understand that in regard to each branch of the undertaking the works are in full swing?

The CHAIRMAN: They are.

A SHAREHOLDER: And doing as much work as the accommodation permits of?

The CHAIRMAN: They are doing more work than we like to have to do in their present contracted condition. We are losing no time, however, in extending the works, which is the important thing.

Dr. DRYSDALE: Do you expect to have some tramways running in London?

The CHAIRMAN: Well, I cannot speak about London; I spoke about provincial towns. We have several provincial towns in which there are actual arrangements being made; I would rather not mention the names at the moment, but I have no doubt before very long you will know al about them.

Dr. DRYSDALE: Is there no chance of London?

The CHAIRMAN: I don't know; I think it is quite possible, but I cannot speak with certainty. We hope that before long we shall not only apply ourselves to the traction question for tramways, but to a far more important question to my mind, and that is railways. I hope that electricity will be applied in the case of railways, and if we once begin I don't know where we will end; but just now we are satisfied with the tramways.

Mr. ROBERT CHIPPERFIELD asked if it was true that the enormous demand far exceeded the power of supply, and, if so, how it was that four, at least, of the concerns they had purchased paid no dividends. If that was the case, was the sum of £400,000 or £500,000 not an enormous amount to be expended in establishing such a company as this, especially when they reflected that similar undertakings had more or less come to grief. He also wished to know on what basis the several purchase considerations were arrived at, and if the promotion money paid in purchasing the several undertakings amounted to something like £150,000. He believed the Elwell-Parker concern was the only one of the companies that paid a dividend. The prospectus stated that it paid a "substantial" dividend. It would be more satisfactory to know what the "substantial" dividend was. He wished, also, to know whether they had contracts for supplying light to the trains spoken of, or whether they simply obtained permission to make experiments, there being no contracts at all. He further asked what expenses they intended to incur in extending the works, and whether, when all the capital was called up, it would be sufficient to carry on all the business of the Corporation for the present without calling up the remaining £50,000.

The CHAIRMAN said the amount of capital was £500,000, of which £50,000 was taken in part payment by those who had sold their businesses to the Corporation; therefore, the actual amount issued to the public was £450,000, out of which they had called up £6 a share, and £4 a share was still uncalled, and remained as an asset to enable them to carry on their work, and to make all their payments. That amount of £500,000 left made a considerable balance for working capital. He sincerely trusted that it would not prove sufficient, or anything like sufficient, for what the Corporation would have to do. His opinion was that it was only the first instalment—if they succeeded as they expected to do—they would have to raise more money; but it was an ample amount for dealing with their present liabilities and providing them with working capital. There were certain questions of detail; for instance, the works at Wolverhampton, which he thought should be left over till the next ordinary meeting. They might be quite sure that the Directors would be very careful not to expend money unless they thought that it was going to produce a thoroughly good result. The present need of the Company was extended works at Wolverhampton, and if they had them now they should be very lucky, because they could fill them with most profitable work immediately. He did not feel inclined to go into some of those questions which affected the original arrangements made, because all these matters were fairly put before the shareholders when the prospectus was issued. It was impossible for him to say what was paid for promotion money. What they did was to purchase the properties for a certain payment, and whether that payment included

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money to other people they had not the means of knowing. All he knew was the amount they were bound to pay to the vendor, Mr. Tarver, and that they meant to pay, and then he hoped they would be able to pay a good dividend on it in due course. He was told that Elwell-Parker paid dividends varying from 10 to 15 per cent.; and with reference to the other companies, he thought the point had been lost sight of by the gentlemen who had been speaking, that the great stepping-stone to success in this Company was the amalgamation of these different interests. He did not think these companies standing by themselves would be worth what the Corporation was paying for them; but the point was this: they were amalgamating those interests and forming a strong buttress against opposition, and the patents which they held became extremely valuable.

Sir DANIEL COOPER, Bart., said he had had to do with the railway lighting for the last five or six years, and he might state that all the contracts for lighting the different railways were written contracts. They had to give them 12 or 18 months at a certain price, so that the officials could judge for themselves whether the companies ought to take the lighting up or not. The officials wanted to be certain that they had got a good thing, and as the Directors knew it was a good thing they gave them all the facilities they could, and that was the only way he thought to promote the business of the company. He belonged to one of the companies whose business had been purchased by this Corporation, and he knew they had got a good bargain. He did not see how, if the Corporation was carried on with skill, and with a proper Board of Directors, it could fail to be a great success.

Mr. GEORGE DIBLEY proposed a vote of thanks to the Chairman for presiding.

Mr. CHIPPERFIELD seconded the motion, which was unanimously agreed to.

The CHAIRMAN acknowledged the compliment, and the proceedings terminated.

NEW COMPANIES REGISTERED.

THE ELECTRICAL ACCESSORIES COMPANY (LIMITED).—Registered by W. T. Cooper, 29, Essex-street, Strand, W.C., with a capital of £5,000 in £1 shares. Objects: To carry on the business of electricians, gas and general lighting engineers, &c.

HAMILTON GRIFFIN AND COMPANY (LIMITED).—The company was registered on the 24th inst., with a capital of £20,000, divided into 5,000 A preference, 5,000 B preference, and 10,000 ordinary shares of £1 each, to transact business as general and financial agents, and to apply for concessions and other powers for the construction and maintenance of railways, tramways, telephones, electric light and power systems and waterworks, in any part of the world.

JOHN WILD AND CO. (LIMITED).—This company has been registered with a capital of £10,000 in £5 shares, to carry on the business of mechanical and electrical engineers, steam, gas, and air engine makers, iron and brass founders, &c. Registered without articles of association.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended September 27, 1889, amounted to £2,867.

CUBA SUBMARINE TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of September, 1889, were £2,400, as compared with £2,774 in the corresponding month of last year. The receipts for the month of June, estimated at £3,300, realised £3,397.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of September, 1889, amounted to £40,418, and to £41,095 in the corresponding period of 1888, a decrease of £677.

EASTERN TELEGRAPH COMPANY (LIMITED).—This company announces the payment, on the 14th October next, of interest at the rate of 3s. per share on the Preference Shares of the Company, less income-tax, for the quarter ended 30th September, and an interim dividend of 2s. 6d. per share on the Ordinary Shares, free of income-tax, in respect of profits for the quarter ended the 30th June last. The register of transfers will be closed from the 7th to 14th October, both days inclusive. The traffic receipts of this company for the month of September amounted to £51,881, and to £49,273 in the corresponding period of 1888, showing an increase of £2,608.

ELMORE'S FOREIGN AND COLONIAL PATENT COPPER DEPOSITING COMPANY (LIMITED).—The first general meeting of this Company will be held at the Cannon-street Hotel, E.C., this day (Friday) at 12 o'clock noon, for the purpose of transacting the ordinary business of the Company. An extraordinary general meeting will be held immediately after the general meeting, when resolutions, rendered necessary in order to comply with the requirements of the Stock Exchange before that body will give the Company a special settlement and official quotation of its shares, will be proposed. Should the resolution be passed by the required majority, it will be submitted for confirmation as a special resolution at a second extraordinary general meeting, of which due notice will be given.

SUBMARINE CABLES TRUST.—Notice is given that on and after the 15th inst., the coupon due in April last will be paid in full by Messrs. Glyn, Mills and Co., of Lombard-street, between the hours of 10 a.m. and 2 p.m. The coupons must be left with the bankers for examination four clear days before payment. Certificate holders are requested to present the coupons for April, 1889, only, and not those payable on October 15th, 1889.

TELEPHONE COMPANY OF AUSTRIA.—This Company has declared the usual half-yearly dividend to 30th ult. on the preference shares at the rate of 6 per cent. per annum, payable early in October.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended September 27, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £1,623.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The traffic receipts of this company for the month ended 30th September, 1889, amounted to £7,250.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The receipts of this company for the half-month ending September 30 amounted to £2,206, as compared with £2,050 in the corresponding period last year, showing an increase of £155. Receipts for the month of June, estimated at £5,907, realised £5,908.

BUSINESS NOTICE.—Our contemporary *Electrical Plant* announces that they are about to open as store rooms premises situate at 39, Queen-street, E.C.

CHANGE OF ADDRESS.—The Westinghouse Company has removed its offices and show-rooms from Gresham House to 4, Victoria Mansions, Victoria-street, S.W.

LEGAL.—THE UNITED TELEPHONE COMPANY (LIMITED) v. NORTON AND COMPANY.—Mr. Justice Denman made an order at the last sitting of the Vacation Court committing Robert Norton, who trades as Norton and Company at Manchester, for contempt in disobeying an injunction made against the firm in 1884. Upon the Registrar being applied to to draw up the order it was pointed out that the original order of Mr. Justice Chitty had never been served upon the defendant, and the case was therefore mentioned to Mr. Justice Denman on Wednesday. Council representing the United Telephone Company urged that the order having been made by consent, and the defendant knowing all about it, service was unnecessary. Mr. Justice Denman said he should leave the matter to be dealt with by Mr. Justice Chitty. It was not a case of any special urgency.

——— In the Westminster County Court on Wednesday, Judge Bayley had before him the case of the Woodite Company *v.* Cole and Co. The action was brought to recover £5. 15s. from the defendants, who are electrical engineers, for certain battery cells made to the defendants' order. Mr. Joseph Weekes, assistant-manager to the company, said the cells were made in the very best way, and there was no fault with them. He explained that the Woodite Company was young, and they were doing their best to put the article before the public. The defence set up was that no order was ever given for any cells, and that the moulds were not made according to the pattern given. After hearing the evidence, his Honour gave judgment for the plaintiffs.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Oct. 2, 1889.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 2, 1889.	
							Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.			
1,770,360	Stock	15/0	Anglo-American	53½ 54½	4 11 9	Jan., Apr., July, Oct.	...	...
2,614,820	Stock	30/0	Do. Preferred	90 91	5 9 11	,, ,,	90½	89⅞
2,614,820	Stock	...	Do. Deferred	18 18½	...	February	18½	18⅛
130,000	£10	5/0	Brazilian Submarine	13½ 14	5 14 4	Mar., June, Oct., Dec.	13⅛	13⅛
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10⅞	5 16 2	Jan., Apr., July, Oct.	10⅞	10⅞
380,000	10	5/6	Eastern	13¾ 14	4 12 10	,, ,,	14	13⅛
70,000	10	6%	Do. 6 per Cent. Preference	15½ 15⅝	3 16 2	,, ,,	...	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	110½	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅝ 13⅞	4 13 10	Jan., Apr., July, Oct.	13⅞	13⅝
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	102½	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	4/0	Globe Telegraph and Trust	8½ 8¾	5 5 8	Jan., Apr., July, Oct.	8 9/16	8 7/16
178,992	10	3/0	Do. 6 per Cent. Preference	14⅞ 15⅛	3 19 4	,, ,,	15⅛	14⅜
150,000	10	5/0	Great Northern	15¼ 15⅜	4 15 3	Jan., July, and April	15 5/16	...
17,000	25	37/6	Indo-European	42 44	5 13 8	April and October	43⅜	...
9,000	8	8/0	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
80,000	10	5/0	West Coast of America	10¼ 10⅜	5 2 4	January and July	10⅜	10⅜
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	127	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	...	...
34,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12⅛	...
4,669	10	*	Do. 6 per Cent. 2nd Preference	14¼ 15½	...	...	...	...
45,181	15	9/0	Western Brazilian	10¼ 10⅜	..	March & September	11	10 7/16
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	⅜ ⅞	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 4	...	...	...
55,000	5	...	United River Plate	5 5½	...	January and July	...	...
			ELECTRIC LIGHT.					
23,008	5	1/2	Anglo-American Brush (£4 paid)	4½ 4⅝	...	...	4	...
23,692	5	2/0	Do. (fully paid)	5¼ 5⅜	...	February & August	5⅛	5⅛
79,934	5	...	Swan United (£3. 10s. paid)	5¾ 6⅛	...	...	6⅛	4⅝
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	45½	...
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19⅝	19

* No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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NOTES.

In our leading article this week we have compared the Colchester installation of 1884 with the Chelsea installation of 1889, with a view to discover the lines along which progress has been made. It is, however, of equal interest to compare with the Chelsea system the one other distinct method of storage battery distribution which has been put prominently before us. The Crompton system, as we all know, is essentially a multiple wire system, in which batteries are employed to maintain the balance in the different sections, the batteries, moreover, serving to provide for the supply during all the hours of light load. This system is, therefore, *primâ facie* the more economical of the two in so far that a portion of the current is supplied direct from the machine to the lamps, and thus escapes the heavy tax of at least 30 per cent. which is levied in transit through the battery. Another apparent advantage lies in the fact that in the normal working of the system there are no circuit changes to be made, —that is to say, the batteries are continuously connected on the one hand with the supply mains, and on the other hand with the charging mains, the whole being charged in series. The regulation of the difference of potential on the lamp circuits is, therefore, the only switching which has to be regularly performed. This is done by hand, a certain number of cells being switched in or out as required. There are still some points about this system which want further explanation—for instance, as to how the charging is regulated, so as to avoid both a cumulative differential treatment of the cells on the one hand, and waste of energy in over-charging on the other. What we are at present concerned with, however, is the prospective rivalry between an automatic and a non-automatic system, and it is much to be regretted that up to the time of our latest information the extension of the Kensington Court installation had not been such as to demand the introduction of sub-stations. We have, it would seem, no concrete example of the Crompton system anywhere nearer than Le Mans.

General Webber differs again from Mr. Crompton on the question of bare conductors. In 1884 he laid some uncovered copper cables on insulite saddles in cast-iron troughing, and although all due precaution seems to have been employed the result was a complete failure. We are not told *how* the failure was caused, but perhaps it is disclosed in the statement that the joints "were believed" to be water-tight, so that probably no provision was made for drainage. It cannot be too strongly asserted that, with bare conductors, success is hopeless unless the conduit is properly drained. It seems inconceivable that this point should be overlooked, yet mains of this class have been recently laid in London under conditions which, as Prof. Forbes remarked in Newcastle, render an explosion some day inevitable. We do not, however, fear such a catastrophe, as the Company in question must certainly before long open their eyes to the facts, even if they have not already done so.

We hear that the experience of the House-to-House Company as regards the insulation of their mains at the West Brompton Station continues to be highly satisfactory. It will be remembered that these are lead-covered cables laid in iron pipes. We have unfortunately forgotten the exact number of megohms per mile which the cables test up to, but it is a remarkably high figure. Speaking of lead-covered cables, it should not be forgotten that at Colchester this type of conductor was in use for over two years, under a tension of 1,250 volts, and never gave any trouble, although the conditions were of a peculiarly trying character.

It is impossible, we think, to deny that Prof. Ayrton (in the Paper on the "Practical Unit of Induction" which we publish this week) makes good his ground that 10^9 C.-G.-S. units, whether it be called a "quadrant" or anything else, is "neither the practical unit of induction, nor is it the secohm of Messrs. Ayrton and Perry." It is sufficiently obvious that the practical unit must have such a value as will fit into the fundamental equation when the other terms are expressed *in practical and not in C.-G.-S. units.* That the B. A. Committee meant the "quadrant" to be a "practical" unit is clear enough, and it would seem impossible to allow the matter to rest without some clearer understanding.

In our esteemed correspondent, Mr. T. H. Blakesley, we find another malcontent on this question of nomenclature. Mr. Blakesley declines to speak of impedance, and prefers the term "effective resistance." Without discussing the relative superiority of these phrases, we may be permitted to observe that Mr. Blakesley has apparently overlooked the fact that the hitherto accepted definition of impedance (up to the time of the late British Association meeting) explicitly recognised that the term related to circuits carrying sinusoidal currents. Mr. Oliver Heaviside (*Electrician*, June 17, 1887, p. 124), when introducing the term, says, "(I use) . . . . Impedance to express the ratio force/flux in the very important case of sinusoidal current."

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Now certainly the case of the sinusoidal current has not diminished in importance since 1887. Not only has Mr. BLAKESLEY himself published a work chiefly devoted to the investigation of this particular case, but further experiment has shown that the currents in actual use conform to this special function to a degree which few ventured to anticipate. The British Association Committee, whilst adopting the term, has, however, widened its meaning, so that it shall signify in general "the ratio of the effective electromotive force to the effective current," as Mr. GLAZEBROOK wrote last week. Mr. BLAKESLEY thinks there is a slip of the pen in this sentence—but we do not follow him here. There are other points raised by our correspondent which we should liked to have commented on, particularly as we are able to see some force in the argument; but space is wanting.

IN connection with the Paris Exhibition awards, to which we referred in our last issue, we are informed that the Compagnie Générale des Lampes Incandescentes, of Paris, was awarded a gold medal for their exhibit of "Edison-Swan" lamps. Messrs. LAING, WHARTON and DOWN, who represented the Thomson-Houston Electric Company in the United States Section, obtained two gold medals—one for okonite wire and one for the Thomson-Houston system. A gold medal was also awarded to the Volta Graphophone Company, of Washington, for Tainter Bell's beautiful instrument, the Graphophone. It will be observed in the list of awards, which we published last week, that only one Grand Prize was granted to the English electrical exhibitors, the firm singled out for this gratifying distinction being Messrs. ELLIOTT BROTHERS. We may remark that the information contained in the official list of awards is very meagre, no mention being made of the particular exhibits for which the various awards are made.

ONE effect of the recent great strike has been to give a new impulse to the formation of trades' unions; and considering the dimensions which electrical industry has now attained it does not surprise us that the artisans employed in it are following the fashion. The reasons assigned are not as intelligible or as manly as we could have wished—one of them being that the electrical workman never knows in the morning whether he will return home in the evening alive, an uncertainty which most of us endure with perfect resignation. A good deal of the pernicious nonsense now prevalent among workmen about offering a united front to the money-bags of the capitalists was repeated at the Paul-street meeting—nonsense which, if the men are as intelligent as we should expect electrical workmen to be, they ought to forswear as soon as possible. The gist of the matter probably is, however, that electrical trades are in that prosperous condition which is generally the signal for a rise in wages; and on the whole, perhaps, this is not a matter to alarm us greatly.

WE understand that Mr. EDISON, during his recent visit to London, stated that he would shortly place on the market an incandescent lamp which could be retailed at less than one-half the price of the present lamps. He also affirms that for the same expenditure of watts per candle-power 25 per cent. more light may be obtained.

To abbreviate a name of twenty-eight syllables is undeniably a laudable operation if carried out with due care. When the name is that of a Committee of the British Association it is, to say the least, desirable that the short title should not mislead as to the character of the Committee. Now, at Newcastle, in the official documents of the Association, we found mention of the "Committee on the Magnetisation of Iron." Naturally we supposed, as did many others, that the Committee of Section A had undertaken to thrash out this enormously wide and vastly important subject; and in our issue of September 27th we expressed our disappointment and discontent with the report as actually read. It now turns out, as may be seen from our correspondence columns, that the Committee was appointed to investigate "Certain Molecular Phenomena associated with the Magnetisation of Iron, Nickel, and Cobalt." This being the case, our recent comments upon the report do not apply, and we withdraw them entirely. But why did the Committee allow itself to receive such a totally misleading designation?

Burnley.—The Corporation intend to apply for an electric lighting Order.

Oldham.—The Corporation intend to make application for an electric lighting Order.

Bolton.—The Corporation have decided to oppose all applications for electric lighting Orders.

Nottingham.—At a meeting of the Town Council on Monday last, it was decided to apply for an electric lighting Provisional Order.

Bangkok.—An electric light company has been established in Bangkok, the King of Siam holding 2,875 shares of the total issue of 6,900.

Segovia.—The machinery and fittings for the Segovia central lighting station have been ordered from Messrs. Julius G. Neville and Co., of Liverpool.

Tynemouth.—At a special meeting of the Town Council, held on Monday, it was decided by 12 votes to 4 to apply for an electric lighting Provisional Order.

Wigan.—The Corporation intend to oppose the applications of electric lighting companies only so far as may be necessary to protect the interests of the borough.

Derby.—A special meeting of the Town Council is fixed for the 9th prox., to pass a resolution in favour of an immediate application for an electric lighting Provisional Order.

The Lighting of the City.—A special meeting of the City Commissioners of Sewers has been called for Tuesday next to finally deal with the question of the electric lighting tenders.

Royal Victoria Hall.—We are asked to state that Madame Nordica will sing for the first time at the Royal Victoria Hall on Thursday, October 17th, when there will be a Grand Ballad Concert.

Rochdale.—The Town Council, last week, endorsed a recommendation of the Gas Committee that the Corporation should not themselves make application for an electric lighting Provisional Order.

Airdrie and Coatbridge.—At the last meeting of the Town Council it was unanimously resolved to advertise the Council's intention to apply for a Provisional Order to light the burgh with electricity.

Dundee.—At a special meeting of the Dundee Gas Commission it was resolved to apply for a Provisional Order empowering the Commission to supply the electric light for public and private purposes within the city.

West Bromwich.—The Gas Committee of the West Bromwich Corporation will recommend to the Council, at a special meeting, to apply for a License or Provisional Order authorising the local authority to supply electricity.

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Kingston-on-Thames.—The Kingston-on-Thames Corporation have decided to apply, in conjunction with other neighbouring authorities, for a Provisional Order to enable them to supply electricity in the district for lighting purposes.

The Russian Telegraph Service.—It is reported (says *The Times*) that all foreigners at present engaged in the Russian Telegraph Service will either have to accept Russian nationality by 1st January, 1890, or to resign their appointments.

East Cowes.—At the last meeting of the East Cowes Local Board a letter was read from the Municipal Electric Lighting Company, asking the Board to support the Provisional Order for supplying Cowes with the electric light. No steps were taken in the matter.

Execution by Electricity.—The New York judge who has been hearing the appeal against the execution of Kemmler by electricity has given his decision that there is nothing unconstitutional in the proposed method, and it is said that the sentence will now be carried out.

Newport.—At the last meeting of the Town Council it was unanimously resolved to withhold the consent of the local authority to the proposed Provisional Orders of the various electric light companies until the subject could be considered by the Island County Council.

West Hartlepool.—At the last meeting of the Town Council it was decided to oppose the applications of the various electric lighting companies for Provisional Orders, on the ground that the Council had under consideration the desirability of itself applying for the requisite powers.

Bacup.—Last week a special meeting of the Bacup Town Council was held to take into consideration the expediency of applying for a Provisional Order to authorise the supply of electricity by the Corporation. It was resolved that the Council should apply for a Provisional Order,

Proposed Classification of Telegrams in France.—It is said that the Minister of Posts and Telegraphs is contemplating the adoption of the Dutch telegraphic classification, namely, fast, slow, and ordinary telegrams, with a view to relieve the pressure on the French telegraph system.

Tenders Open.—Tenders are to be sent by the 24th inst., either to the Chief Postal and Telegraph Department at Madrid, or to the telegraph office at Segovia, Spain, for the establishment and working of a telephone exchange in the town of Cora, in the province of Segovia.

Barnet.—At the last meeting of the Local Board a letter was read from Messrs. Joel and Co., to the effect that negotiations were in progress for transferring the lighting contract to the "United Gas Improvement Company," which own the English patents for the Heisler system of lighting.

Stockton.—At the monthly meeting of the Stockton Town Council, held last week, the town clerk and gas manager submitted a report upon the question of electric lighting, in which they advised the Corporation to apply for a Provisional Order authorising them to supply electricity within the borough.

Reading.—At the last meeting of the Reading Town Council the Highways Committee reported that they had considered the subject of arranging with Messrs. Laing, Wharton and Down for the lighting of a district of the borough with electricity, and thought it was not advisable to proceed with it at present.

Athens.—On the occasion of the marriage of the Crown Prince of Greece the streets of Athens are to be lighted by electricity. The contract has been given to the Edison Continental Company, who have sent out four 500-ampere Edison dynamos, and two 170 horse-power Weyher and Richemond engines.

Devonshire Club.—Very extensive alterations are being made to the club, including the introduction of the electric light throughout the building. Messrs. Drake and Gorham inform us that several new features in lighting are to be introduced, which they expect will be very generally adopted throughout the London clubs.

Electrical Engineering Appointment. — Mr. Alexander Stewart, who studied electricity at the Glasgow and West of Scotland Technical College under Prof. Andrew Jamieson, has just been offered an important position in the new shipbuilding yard of Messrs. Palmer and Co., at Bilbao, namely, that of naval architect and electrician for the works.

W. T. Henley's Telegraph Works Company.—We have received the September price list of electric light cables and wires of this well-known firm. The list contains full information with regard to the price, gauge, insulation, weight and resistance of the various sizes of conductors. Quotations are also made for electric light casings in American whitewood, redwood, and pine.

Falmouth.—The Lighting Committee of the Falmouth Town Council have had under consideration the question of electric lighting, and their recommendation, adopted by the Town Council, is that the Corporation and Local Board of Falmouth, the Penwerris Lighting District, and the Corporation of Penryn be invited to join in obtaining powers for supplying the district with the electric light.

Electric Traction on the South London Tramway Company's Lines.—An experimental trip was made last week by a Jarman electric car on the South London Company's line. It is expected that six of these cars will be running regularly in about a month's time. The distinguishing feature of the Jarman system is, it will be remembered, the employment of two separate motors mounted on the same spindle.

Croydon.—At the last meeting of the Croydon County Council, the following resolution was formally moved, and its consideration adjourned until the next meeting:—"That the Council do apply for a Provisional Order giving to the Corporation electric lighting powers for Croydon, and that it be referred to the General Purposes Committee to report as to the necessary details of the application."

The Institution Dinner.—The dinner of the Institution of Electrical Engineers will take place at the Criterion, Piccadilly, on Monday, the 4th of November, at half-past seven o'clock. Those who desire to attend must send in their applications to the secretary as early as possible. Should the number of tickets applied for exceed the accommodation available, the applications will be dealt with in the order of their receipt.

Electricity in Mines.—Electric traction is about to be introduced into some coal mines near Scranton, Pennsylvania. One mine will have an electric road over a quarter of a mile long. It is expected that a large saving will be effected. At present, 12 mules, with runners and drivers, are used to haul the cars from the head of the slope to the bottom of the shaft. Electric lighting will also be introduced at the same time.

The Striking of Trees by Lightning.—The *Elektrotechnische Echo* is responsible for the following explanation of why oaks are more frequently struck by lightning than beech trees. The leaves of the beech tree are, it seems, covered with a fine down, which is a better conductor of electricity than the smooth leaves of the oak. According to the same journal, experiments with discharges from influence machines tend to confirm this theory.

Cheap Telegrams in Hungary.—According to the *Daily News* correspondent at Budapest, the Hungarian Board of Trade is making plans for an important reform. The charges for telegraphic messages are to be organised afresh, and to be proportionate to the distance to which the messages are sent. Two kreuzers, or less than a halfpenny per word, will be the charge for telegrams to Austria. Local messages will be charged half a kreuzer, or the tenth part of a penny, per word.

Portsmouth.—The Portsmouth and South Hants Electric Supply Company, which has already applied for Parliamentary powers, has given the contract for the erection of the central station to the House-to-House Company. The station will be a duplicate of the one which that company has in operation at West Brompton. A large number of hotel-keepers and tradespeople in Portsmouth are giving the scheme their support. The Portsmouth Town Hall is being fitted with electric light appliances by Messrs. Haden and Son, of Manchester.

Sale by Auction.—We have received from Messrs. Wheatley, Kirk, Price and Goulty a carefully-printed catalogue of the fixed and loose plant, and machinery, &c., to be sold by auction by them on Tuesday, Wednesday, Thursday and Friday next, at the works

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of Messrs. Appleby Brothers, Limited (in liquidation), at East Greenwich. The sale includes a large quantity of high-class engines, boilers, tool-cutting machines, shafting, pulleys, &c. Further particulars will be found in our advertising columns.

Submarine Cable Tender.—The Direction-Générale des Postes et Telegraphes invites sealed tenders for the material of a submarine cable: (1) Galvanized iron wire 2·5 millimetres in diameter (2 lots); (2) tarred jute strips (1 lot); (3) submarine cable core (2 lots). The conditions of tender may be inspected at 103, Rue de Grenelle, Paris, any day (except holidays) between the hours of 11 and 4, and also at the chief telegraph offices. The tenders will be opened on the 22nd of this month.

Price List of the "Sunbeam" Lamp Company.—The "Sunbeam" Lamp Company are now manufacturing incandescent lamps from 200 up to 1,500 candle-power. They are made in two classes, A, high efficiency, B, longer duration, the former taking only two watts, and the latter two and a-half watts per candle. The "Sunbeam" lamp is likely to prove very useful for certain kinds of street lighting and has already been extensively employed on board ship and in the lighting of large halls. The prices charged are very moderate.

A New Spray Arrester.—The fumes arising from batteries are at times found extremely troublesome, and different methods are in use for their prevention. Messrs. Drake and Gorham have recently introduced a special preparation of light material, which is floated on the acid. Every crevice is effectually covered, and it is found that secondary batteries, even when overcharged to any extent, cause no nuisance when thus protected. The cost is stated to be very trifling—in fact, considerably less than the glass plates which are usually employed.

Electric Traction on the North Metropolitan Tramway.—On Tuesday last week the last of the five accumulator cars of the Electric Traction Company was put on the North Metropolitan Tramway at Canning Town, and the whole of that line is now worked by electricity. For some weeks past the cars have been added one by one to work among the horse cars, and 15,000 car miles have now been run upon this line by the accumulator cars with only a loss for stoppages of 2 per cent. of the total possible mileage. The cars carry a complement of 52 passengers.

Strand Union.—Tenders have been received for electrically lighting the Board room and offices of this union from the following firms:—

Messrs. Rashleigh Phipps and Dawson, Berners-street ...	£88 0*
Messrs. Hart, Son, Peard and Co.	98 15
Messrs. Vaughan and Brown, Kirby-street	86 0
Messrs. Verity and Sons	81 7

* With £18 extras.

The tenders were referred to the General Purposes Committee for consideration.

Telegraphic Cables in the Philippines.—A few months ago we announced that an invitation for the construction of inter-insular cables in the Philippine Archipelago had been withdrawn owing to no tender having been sent in. Tenders were again invited, and advices from Madrid report that the Committee appointed to take charge of the matter met last week under the presidency of the Colonial Minister, and reported that one tender had been submitted, viz., by Mr. Clavet, in the name of the Eastern Extension, Australasia, and China Telegraph Company (Limited). The Committee decided to consider the proposal, and report at an early date.

Edinburgh Electrical Exhibition, 1890.—The Committee under whose management the electrical branch of the Exhibition will be placed has now been constituted as follows:—A. R. Bennett, General Manager, National Telephone Company; Principal Grant Ogilvie, Heriot-Watt College; Prof. G. F. Armstrong, Edinburgh University; J. Gibson, Superintending Engineer, Postal Telegraphs; A. F. Clement, Telegraph Superintendent, North British Railway; Dr. A. C. Elliott, Edinburgh University; D. A. Stevenson, Engineer to Commissioners of Northern Lights; Colonel Malcolm, Royal Engineers; J. Monteith, Carstairs House; G. Auldjo Jamieson and Hugh Auld, the three last being gentlemen locally identified with the progress of electrical science.

City and Guilds of London Central Institution.—At the termination of last session the John Samuel Scholarship was gained by A. E. Young, and the Siemens Medal for the student of greatest merit in the department of electrical engineering by C. G. Lamb. At the entrance examination for the new session held this month the Clothworkers' Scholarship of £60 a year, tenable for two years and renewable for a third year, entitling the successful candidate, in addition, to free education, was gained by H. C. Haycraft; the Mitchell Scholarship of £30 a year for two years, with free education, by F. H. Hummell; the three Institute's Scholarships, of sufficient value to cover the student's fees, each tenable for three years, by R. W. Weekes, H. E. J. Taylor and E. G. Ingold; and the Public School Scholarships, entitling the successful candidate to free education, by R. L. Jenks and C. Mills.

Obituary.—We regret to have to announce the decease of the head of the old-established firm of Hick, Hargreaves and Co., proprietors of the Soho Ironworks, Bolton. Mr. William Hargreaves died at his residence, Moss Bank, Halliwell, near Bolton, on the 1st inst. The deceased gentleman was in his 68th year, and had been in failing health for a considerable period. Mr. Hargreaves has been head of the firm since 1868. It may be of interest to note that this firm was the first to introduce the Corliss engine into this country. Messrs. Hick, Hargreaves and Co. have also achieved considerable celebrity in the development of massive hydraulic and electric lighting machinery and plant, one of their latest works in this direction being the construction of two pairs of engines of 3,000 horse-power and two other pairs of engines of 10,000 horse-power for the London Electric Supply Corporation.

London County Council.—The Highways Committee of the County Council reported last week that it had assented to the House-to-House Electric Light Supply Company laying mains for the supply of electricity in Kensington. The Council expressed its disapproval of the works referred to in the notices issued by the Kensington and Knightsbridge Electric Lighting Company, on account of the largeness of the distributing boxes which the company proposes to adopt. The Council gave its sanction to the notices issued by the London Electric Supply Corporation; the notice referring to the works to be commenced at once by the Metropolitan Electric Supply Company; the works specified in the notice of the Chelsea Electricity Supply Company, providing that the covers of the distributing and other boxes consisted of iron frames filled in with stone or other material to suit the paving; and the laying of the St. James's and Pall Mall Electric Light Company's mains, upon condition that the work was carried out to the satisfaction of the proper authorities.

An Electrical Trades Union.—A meeting of electric engineers and linesmen, of whom it is estimated there are about 3,000 in London, was held last Saturday at the Paul's Head, Paul-street, Finsbury, to discuss a proposal as to the means for the formation of a society in London on the Trades Union principle. The workman who was elected to the chair wished his name—as did also the speakers who followed—to be suppressed, in view of future reprisals from the firm by which they were employed. In opening the proceedings the chairman said he was very much surprised that such a Union as was then under consideration had not been formed before. As a matter of fact, their leaders had been responsible for the delay, but now that they had commenced in earnest they could see plenty of useful work before them. Throughout the trade wages were far too small, considering the dangers they had to incur; for when they started out in the morning there was not one of them who could say with any certainty whether he would be alive in the evening. He did not believe in strikes, but he did believe that when their Union was duly established on a sounder basis it would do valuable work in the way of calling in an independent arbitrator in the event of a trade dispute ultimately taking place. Mr. Donald, Labour Union, urged organisation, so that labour might reap the benefit of the wealth it created. A hearty vote of thanks having been accorded to Mr. Donald for his speech, a letter was read from the Manchester Union urging the London men to amalgamate, and it was decided that the Union should be formed.

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THE PRACTICAL UNIT OF INDUCTION.

BY W. E. AYRTON.

On page 454 of *The Electrician* for September 6th, which I have just seen on my return to town, I find the following in the report of the recent Paris Electrical Congress :—

"The results of this discussion, as embodied in the votes of the Section, were as follows :—

"1. The name 'quadrant' was adopted for the unit coefficient of induction. This is equal to 10^9 C.-G.-S. units, and is the same as the secohm of Messrs. Ayrton and Perry."

I have also heard during the last few days that this name "quadrant" was subsequently adopted by the Electrical Standards Committee of the British Association at their meeting at Newcastle, last month.

Permit me, at this somewhat late period, to point out that 10^9 C.-G.-S. units is neither the practical unit of induction nor is it "the secohm of Messrs. Ayrton and Perry." For the practical unit of induction, whatever name you like to give it, is that unit which when used to measure L in the following equation—

$$r\,C + L\,\frac{dC}{dt} = E,$$

makes that equation true, where r is the resistance of the circuit measured in the so-called legal ohms, C the current measured in amperes, and E the E.M.F. measured in *practical* volts. Now, without waiting to express my opinion on the question which I understand occupied the attention of the British Association Committee, viz., whether an induction is really a length, or is only numerically represented by the measure of a length, it is quite certain that the *practical* unit of length in the preceding inductional equation is not 10^9 centimetres, and therefore that the *practical* unit of self-induction cannot be that length.

Although the legal ohm is perfectly defined as the resistance of 106 centimetres of mercury, one square millimetre in section at 0°C., the *exact* velocity which corresponds with the legal ohm is not yet known. It is certainly not 10^9 centimetres per second, and is probably about 99777×10^4 centimetres per second. If, then, we desire to define the *practical* unit of induction as a length, we certainly cannot say that it is 10^9 centimetres, since the practical unit of induction must satisfy the practical inductional equation given above. We might logically say that the practical unit of induction was "*probably about* 99777×10^4 *centimetres*," but such a statement would not constitute a scientific definition. In fact it will be impossible to state the exact length that corresponds with the present practical unit of induction until the exact velocity corresponding with the legal ohm is known.

A few years ago, when the B. A. unit of resistance was the recognised ohm, the practical electro-magnetic unit of length was *about* 98668×10^4 centimetres; to-day it is *about* 99777×10^4 centimetres, and if the accuracy of experimenting can be immensely increased, and national jealousy entirely overcome, some of us may live to see this practical unit of length reach the scientific goal of 10^9 centimetres by successive stages of Darwinian process. But as long as that unit of length is not accurately known, and as long as the difference between it and 10^9 centimetres is probably over 2 in 1,000—a difference that it is easy to measure electrically—it appears to me now, as it appeared to Prof. Perry and myself nearly three years ago, that the proper definition of the practical unit of induction should not be based on any approximate length (still less on the exact length of 10^9 centimetres, which is certainly not the measure of the practical unit of induction). On the other hand, just as the legal volt is defined in terms of the legal ohm and ampere, to make the equation

$$r\,C = E$$

true for steady currents, so it appeared to us that the practical unit of induction should be defined in terms of the ohm and the second, so that the equation

$$r\,C + L\frac{dC}{dt} = E$$

might be true for ohms, amperes, units of induction, seconds, and volts.

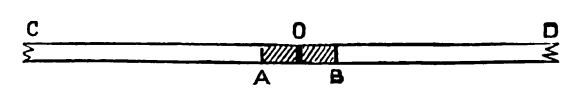
Whether the name "secohm," which we then suggested as a contraction of second and ohm, was a happy one is for others to judge, but I feel as sure now as I did then that the idea underlying that name is correct. With a box of accurately adjusted legal ohms and a good watch, one can, *without the use of any other standards*, measure the self-induction of a coil in secohms theoretically to any degree of accuracy desirable, a result not theoretically possible if the result has to be stated in "quadrants." On the other hand, if the self-induction of a coil be accurately known in quadrants, then, since the resistance of a circuit can only to-day be expressed with *theoretical* accuracy in legal ohms if the result is to have *international* consent, it is impossible to use the inductional equation to measure with theoretical accuracy the growth of the current in the circuit in amperes.

Now, although for practical purposes the error of a few tenths per cent. in a measurement is often of no consequence, it appears to me that as the ideas of induction are only now being grasped by practical men, it is of the utmost importance that the definition of the *practical* unit of induction should be rigorously exact. I am also extremely doubtful whether any practical electrician's conceptions of self and mutual induction would in the slightest degree be extended by the practical unit being defined as a length (even if it were possible to exactly state that length); and I am quite certain that such a definition would give him no assistance whatever in measuring with a metre scale the self-induction of even an ideally simply constructed coil, still less of any coil that he is likely to have to deal with. Self-inductions will, I fancy, continue to be measured for some time to come by practical men as they have been measured during the last year or two, and as long as the present legal ohm is the standard of resistance, self-induction will be expressed in a unit which has had no name given to it by the Paris Congress or by the British Association, and the value of which cannot yet be exactly stated with international consent in terms of a length, and therefore cannot be exactly stated in terms of the adopted unit, the "quadrant."

THE ELECTROMOTIVE FORCES PRODUCED BY THE CONTACT OF SIMILAR METALS AT DIFFERENT TEMPERATURES.

BY HERBERT TOMLINSON, F.R.S.

Both Prof. O. Lodge and Mr. Shelford Bidwell in commenting (*The Electrician*, October 4, p. 546) on Prof. H. Stroud's Paper, "The E.M.F. Produced by an Abrupt Variation of Temperature at the Point of Contact of Two Portions of the same Metal," do not agree with Prof. Stroud in his interpretation of the results obtained by him. The present writer is inclined to believe with Prof. Lodge and Mr. Bidwell that the results obtained by Prof. Stroud are not due to the electromotive force of the Thomson effect, and would suggest the following as a possible explanation :—



Suppose that C D is a tube of copper of exactly the same structure throughout, and that we strike it with a hammer at O. The effect of the blow will be to modify the molecular structure of the tube for some little distance on either side of O; let A B be the portion of the tube thus modified. Now let us keep the portion of the tube at A warmer than the portion at B, then an E.M.F. will be developed in the direction A B. When Prof. Stroud cuts his tube, the act of so doing permanently modifies, by mechanical means, the molecular structure of the portions at and adjacent to the cut, and the modification, of course, persists after the cut surfaces have again been brought into contact

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with each other; the tube C D is no longer of the same structure throughout. As a consequence of this, when opposite sides of the cut are maintained at different temperatures, we obtain Prof. Stroud's E.M.F., which is in a direction indicating that the act of cutting the tube alters the thermo-electric power of copper in the same direction as the act of hammering. If for copper we substitute iron, the E.M.F. should be reversed in direction, as Prof. Stroud finds, for the thermo-electric powers of copper and iron are affected oppositely by the same mechanical processes. If the above view of the matter be correct, Prof. Stroud's observed E.M.F. should be lessened* or entirely destroyed by *annealing* the pieces *after cutting*.

Prof. Magnus has fully investigated the currents produced on causing hot and cold wires to touch each other, and a concise account of his work will be found in Tyndall's "Researches on Diamagnetism and Magne-Crystallic Action," p. 296. It will, perhaps, be not out of place to compare in the following table some of the results of Prof. Magnus with those of Mr. Bidwell:—

Contact current hot to cold = +. Cold to hot = −.

Metals.	Magnus. One wire 100° C., the other 8° C.	Magnus. One wire 250° C., the other 8° C.	Bidwell.	Thomson effect.
Iron	.....	.....	−	−
Platinum	+22	+80	+	−
German Silver	−72	.....	+	−
Cadmium	+15	.....	+	+
Zinc	+28	.....	+	+
Silver	− 3	−17	−	+
*Gold	+ 6	+28	−	+
Copper	− 8	.....	−	+
Lead	0	.....	0	0
Tin	−10	.....	+	+
Nickel	.....	.....	+	−
Palladium	.....	.....	−	−

* The gold of Prof. Magnus was alloyed with 2·08 per cent. silver.

The numbers in the second and third columns of the table are the degrees of temporary deflection of the galvanometer needles produced by suddenly bringing the hot wire into contact with the cold one, and will, therefore, for the most part represent approximately the relative values of the resulting electromotive forces. It will be observed that the direction of the E.M.F. in the lists of metals furnished by Prof. Magnus and Mr. Bidwell is not in all cases the same. This may arise partly from the fact that the metals were not of the same degree of purity in the two cases. The writer many years ago made experiments on the same subject. His results agree with those of Mr. Bidwell as regards the direction of the E.M.F. in iron, German silver, platinum, lead, silver, nickel, zinc, and pure copper. The one specimen of commercial copper examined by him gave a + sign, but another specimen examined recently, and probably of better quality, was −. With a specimen of nearly pure tin a − sign was found. These conflicting results, obtained by different experimenters, plainly show us that we must be on our guard as to drawing conclusions respecting any relations which there may or may not be between the Thomson effect and the thermo-electric currents produced by the sudden contact of hot and cold wires. The two things ought to be determined not with different specimens of the so-called same metal, but with the self-same specimens.

In connection with the matter in hand it may perhaps be of interest to the readers of *The Electrician* to learn that a temporary E.M.F. can be developed by suddenly putting two wires of the same metal, one hot and the other cold, into a liquid. In most cases the direction of the E.M.F. seems to be the same at all temperatures of the hot metal where ordinary water is the liquid employed, but in the case of copper it is not so. When either pure or commercial copper wire is heated to a temperature under 100° C., it becomes positive with respect to copper at 15° C. when the two wires are simultaneously put into water at 15° C.; and when it is heated above 100° C. it becomes negative. An easy way of showing this is to connect two pieces of copper wire with a galvanometer of many turns; heat one of the free ends in a glass tube to a temperature of 300° or 400° C., and then simultaneously place the two ends about ½in. apart on a piece of wet paper. If the galvanometer be at all sensitive there will be at first a strong deflection, showing a current from cold to hot copper through the wet paper; this deflection will rapidly subside, and then a deflection in the opposite direction ensues. If ammonium sulphide be used instead of water, the hot copper is negative to cold copper—at any rate up to about 300° C., and probably beyond, though this was not tried.

* It is often very difficult to *entirely* annul by annealing the effects of mechanical processes.

REVIEWS.

Incandescent Wiring Handbook. By F. B. Badt. (Electrician Publishing Company, Chicago, 1889.)

This is a useful little book of American origin, and containing in its sixty-five pages a great deal of practical information on a subject about which very little has ever yet appeared in print. It is a book which, with some corrections adapted to English ideas, and which we shall note below, might usefully be placed in the hands of every foreman engaged in house-wiring. The author displays sound, common sense in going straight at the practical details, omitting any unnecessary preliminaries under the pretence of imparting scientific information. Chapters I. and II. each consist of less than half a page of print, and describe respectively the ordinary parallel (here called "multiple-arc") and the three-wire system, just so far as a wirer needs to understand them. The diagrams are good. Chapters follow on cleats, mouldings, and concealed-work, and some practical hints are given as to fishing for wires under floors or behind partitions in a completed building. The author very properly insists that in new buildings the architect should make ample provision for electric lighting wherever there is any probability of its coming into use. This can be done at a trifling additional cost whilst the erection of the building is proceeding, and may save a good deal of expense, to say nothing of inconvenience at a later date. Even if no more is done, it will often save much tiresome labour if in each room of the house one of the spaces running between the joists under the floor is kept clear of obstruction, or if a passage-way is cut in such as are inevitable. A small draw-wire should be laid in each such channel, and they should be made continuous from room to room upon the same floor. Vertical channels in corresponding positions should be cut in the brick-work of the walls. A still better plan—which the author does not mention, although it has come into use both here and in America—is to provide suitably arranged tubing throughout the premises, into which the wires can at any time be drawn. This system was strongly commended at the recent meeting of the Edison Illuminating Companies at Niagara Falls.

But, undoubtedly, whenever practicable, the most satisfactory way is to complete the wiring whilst the house is being built. The best time for doing the work is "when the builders have finished boarding in, and have not yet begun lathing." The author estimates that at this time the cost of wiring is sometimes not more than half as much as in the finished structure. But this remark will scarcely apply over here, where labour does not bear so high a proportion to the total cost.

Mr. Badt has not very much to say on the "location" of switches and cut-outs, nor can very much be said; this is a detail which must be settled by a responsible person in reference to the circumstances of the case.

In America, however, they are more partial than we are here to the system of bringing together as many switches and cut-outs as possible at one point. Mr. Badt lays it down that "it is not necessary that each room should have its own switch," and he votes in favour of double-pole switches on the ground chiefly of convenience of testing, He might have added that they have also a tendency to provide occupation for the tester. For soldering he prefers acid on the ground that the workmen will make a better job than with resin. This is a point upon

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which practice is very varied, but there is little doubt that when the job is in the hands of first-class workmen (where alone it ought always to be), resin is the right flux. Mr. Badt, by implication, allows unsoldered joints; there is a sentence on page 21 which should therefore be erased before the book is placed in the hands of an English foreman. In fact, in the matter of joints, all our best contractors can "give points" to the Yankee. Unhappily, there is still so much work being done by more or less incompetent people, and these may learn something even from American practice in this particular.

Safety rules we pass by, as we have our own versions to strive to live up to. The chapter on "Insulation and Testing" is mainly the reprint of a passage taken from a Paper by "Prof." J. D. F. Andrews (see *Electrician*, April 5, 1889, p. 619). (We may remark in passing, that in such honour do American writers hold the English school that every year the honorary degree or title of Professor is conferred by them upon a number of our esteemed countrymen. Prof. Reckenzaun holds, we believe, the premier distinction, but we have also Professors Rankin Kennedy, Esson, Mordey, and Swinburne, all holding American degrees; and now we have to congratulate a respected Glasgow contractor on his attainment of the same high distinction. May we venture without impropriety to suggest that some surprise has already been expressed that the claims of Mr. Killingworth Hedges have been so long overlooked?)

Returning from this digression we note that the author very properly urges the necessity for paying attention to the insulation of every wire as it is put in. Probably a more extended use of the magneto-bell in the hands of properly-instructed foremen would often save a lot of subsequent trouble.

There is a useful chapter on the wiring of fixtures and lifts, and one on wire gauges; and then we come to some "General Electrical Data," which has at least the merit of brevity.

The last twenty pages are on calculating the size of wires. Six "Rules" are given for this purpose, which will be useful to such people as do not readily grasp the purport of a simple algebraic formula; those who do won't bother themselves much about "rules." In the examples with which the application of the rules are illustrated Mr. Badt usually takes the fall of potential in the wires at 10 per cent.! Not only is this a quite impossible figure in house-wiring, but for short lengths it is very likely to suggest to the too-trustful disciple a wire which, with the proposed current, is certain to overheat. We are indebted to Mr. Badt for the information that "the National Board of Fire Underwriters specifies that the carrying capacity of a conductor is safe when the wire will conduct a certain current without becoming painfully warm when grasped by the closed hand." *Whose* hand is not specified, but before the law can become of general application it is clear that we shall want a definition of the standard hand as regards its capacity for standing "fire." All through this chapter on "Safe Carrying Capacity" we find we don't like the author *quite* as well as we did before. We do not dispute that "in nature nothing is lost," but we did not expect that Mr. Badt would remind us of it.

Lastly we come to an ingenious table (contained in a separate pocket in the cover) which enables one to find the size of wire required for a given number of lamps of given voltage at a given distance, with any fall of potential from 1 per cent. to 15 per cent. There are three distinct tables, for 55, 75, and 110 volts respectively. The size of the wire is found in circular mills, and in Brown and Sharp's gauge.

On the whole, it is impossible to resist the conclusion that American ideas in this matter are scarcely on a par with our own. The very fact that a wiring table is calculated for various falls of potential, from 1 to 15 volts, would seem to show that more attention is paid to what is, after all, a small saving in the cost of copper than to safety and efficiency. In this country, although no doubt plenty of bad work is still being done, it would nevertheless be difficult to find many installations with a drop of 5 to 10 per cent., such as Mr. Badt chooses to "figure on" (to use the elegant native expression). Amongst the best firms in this country the custom in house-wiring is to calculate the more important mains and branches for a fall of 1 per cent., and then to instruct the foreman that the current density in the remaining leads is in no case to exceed a fixed quantity, say 500 or 700 amperes per square inch. The foreman is not then required to find out anything further than the number of lamps which the wire will have to carry, and at the same time safety and efficiency are practically assured. This is well worth the slight extra cost which may be incurred.

Electricity in our Homes and Workshops: A Practical Treatise on Auxiliary Electrical Apparatus. By SIDNEY F. WALKER, M.I.E.E., &c. (London: Whittaker and Co.; George Bell and Sons, 1889.)

If the author had seen fit to dispense with the first part of the above title, the remaining half would have given by itself a better idea of its style and contents, and we should think the excision would have materially assisted the volume to reach the class for whom it is intended—and to whom, we may at once add, it should prove very serviceable. It would be difficult to find a more painstaking writer than Mr. Sidney Walker when he is describing the conditions of practical success in a field which he has himself thoroughly explored. The chapter on Electric Mining Signals is itself a mine of apparently exhaustive detail on the subject of which it treats. Nor is it for a moment to be supposed that the subject is either a simple or an unimportant one. To design and maintain economically a set of electric bell signals under the conditions of damp and exposure to rough usage which are found in a coal mine presents a problem of which nothing but skill and foresight, but above all experience, can furnish the complete solution. Mr. Walker's book will now enable all who are practically concerned in the business to participate in the lessons which experience—often evidently of a costly and painful character—has imparted to him. The author does not confine himself merely to suggestions as to the design of the installation; he considers in much detail the character of the faults likely to arise at the various points, and how they may be most quickly traced and best remedied. The sections which relate to the method of procedure in testing for a leakage or a disconnection, which cannot readily be found, should be the means of saving an immense amount of time and trouble to persons inexperienced in the work. One is not surprised to learn that the vertical wires descending the shaft are chiefly liable to injury, and most difficult to repair. The author prefers to use one covered copper and one bare iron wire in this situation; he gives reasons for this at length, but we must refer readers who wish to study the question to the book itself.

The leading principle on which the author again and again insists is that for economical work in any description of electric bell-hanging you must have large cells. Pint cells, he would probably say, may sometimes be good enough, but quart cells are always better, and the half-gallon size is invariably best of all. This, of course, refers to cells of the Leclanché type. The author estimates that the annual cost of maintenance varies inversely as the size of the cell.

Besides the chapter on Mining Signals we have chapters on Electric Bells, Batteries, and Telephones, all of which are practical and useful.

Of the remainder of the work (which is, in fact, the three first chapters) we cannot speak so favourably. For the "young electrical engineers who are just commencing to make their practical experience," for whom the preface says the book is meant, the chapter on elementary principles should be wholly unnecessary. The chapter on "The Electric Current" and the one on Magnetism contain some good points, but they are occasionally marred by a looseness of statement which should not have been allowed to pass. It is neither an wholesome nor even a truthful doctrine to say that "Carbon, like every other known body, is soluble by the current." The author deals strangely with the term "magnetic circuit;" he speaks of "breaking" and "making" it as if it were the exact analogue of the electric circuit. We may properly speak of "opening" or "closing" a magnetic circuit, but we certainly can neither break nor make it. We are told that "when a permanent steel magnet is brought near a piece of iron or steel, magnetism is induced in it *provided* it lies in the path of the magnetic circuit." The only "proviso" really required is that the perma-

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nent magnet shall not take the shape of a closed ring; otherwise the iron will surely lie "in the path of the magnetic circuit."

Lastly, we are bound to call attention to the one serious practical error which we have noted, and which will be found on page 40. Mr. Walker there and on earlier pages warns the student that Ohm's law must be rigorously applied to insulators, but he has not a word to say about the far more important point of surface leakage.

A NEW ALTERNATING-CURRENT MOTOR.*

BY LIEUT. F. JARVIS PATTEN.

On giving our secretary the title of this Paper it was my purpose to treat the subject in a broader light, and to show the progressive steps in a series of experiments which led eventually to the type of machine that I shall bring to your notice this evening. The recent and urgent claims of other work have rendered such a treatment impossible at the present time, and I shall limit the Paper to a description of a new alternating-current motor, one form of which is shown in the accompanying drawings.

The place that the alternating-current electric motor is destined to fill in the industrial arts is familiar to you all, and the various ways known to the scientific world by which such machines may be rendered operative have been ably considered and elaborately discussed in the Institute Papers of the past two years by Professor Thomson, Dr. Duncan, and Mr. Tesla; we are thus all more or less acquainted with the prominent difficulties of the problem.

My experience, in common with that of my predecessors, teaches that the alternating-current motor has a strong and persistent disposition to stand still, and when persuaded to motion it is apt to be a sort of "go-as-you-please" machine, and asserts its inherent right to turn in either direction indifferently; direction of rotation in some cases being purely a matter of chance. I shall not have much to say about efficiency, as my experiments with large machines are not sufficiently advanced to furnish any reliable data, but I will endeavour to give a general solution of the problem designed to meet the following conditions of practice:—

1. A machine that will start itself independently of the speed of the generator or number of alternations of current per unit of time.

2. A machine that has but one direction of rotation and cannot reverse under any conditions of current alternation.

3. A machine that is not necessarily synchronous with the generator, revolution for revolution.

4. A machine in which reversals of current direction do not produce corresponding reversals of magnetism in any iron part, when the machine is in motion at its normal speed and maximum efficiency.

5. A machine of simple form, having an ordinary continuous-wound armature revolving in a single or two-pole field.

Referring now to the figures which are simply diagrams of the circuits and operative parts, we have in Fig. 1 an ordinary closed circuit armature shown as a Gramme ring merely for convenience of illustration, the points of the winding intermediate between the eight coils being connected in the usual way to the eight segments of bars of an ordinary Gramme collector, and it may be well in passing to note here the function of this collector. It is not a commutator in the strict sense of that term, as it does not rectify or re-direct reverse or opposed currents. If the brushes b^1 and b^2 were held upon the outside wire of the ring the same results would follow, and the Gramme collector, properly so called, singly transfers the brush contact from point to point of the continuous ring winding. If a source of direct current be interposed between the terminals A^1 and A^2 current will flow continuously from brush b^1 to brush b^2 downward through the right and left-hand halves of the ring in the direction of the arrows k^1 and k^2, making, say, a south pole in the ring at the upper point S, and a north pole at the lower point n. With a continuous current these poles would be continuously maintained and placed in the magnetic field indicated by N and S; the armature would continuously revolve in the direction indicated by the arrows re. If now a source of alternating current be inserted between the terminals A^1 and A^2 the polarities of the ring would be reversed at each successive alternation of current, and if a direct impulse, indicated by the single arrows in the external circuit, produced the poles n and s in the ring, the reverse impulse indicated by the double arrows would produce the opposite polarities n^1 and s^1 at the same points, and the tendency to motion would be reversed if the fields remained the same, but it will be noted the motion would be in the same direction still if the fields also were reversed by the same reversal of current. If, however, the fields were maintained constant, as indicated by the large letters N and S, and some device could be contrived by which at each reversal of the alternating current the brushes b^1 and b^2 could be made to change position, either mechanically or otherwise, then with an alternating current a constant polarity, s and n, would be maintained at the upper and lower points of the ring—for then a direct impulse starting from A^2 to the right would enter the ring through the brush b^1 flowing down both sides in the direction of the arrows k^1 k^2, out through brush b^2 and back to the source at A^1. The reverse impulse indicated by the double arrows would start from A_1 to the left, going to brush b^2, and if we now suppose this to have changed places with the brush b^1 the reverse current would then enter the ring at s and flowing down both sides in the direction of the arrows k^1 and k^2 would leave through n and the brush b^1 and so back to the source A^2, maintaining the polarity of the ring the same as before. If the brushes could be thus changed at each alternation, the polarity of the ring would be maintained constant with an alternating current. While, however, it is quite impractical to thus cause the brushes to change position mechanically at each reversal of current, it is perfectly feasible to produce the same effect without the mechanical change. The means of accomplishing this result are indicated in Fig. 2, which is identical with Fig. 1 with a single exception. There are eight coils as before, and eight bars in the collector, the odd-numbered bars, 1, 3, 5, and 7, being connected to the same points of the ring as before, c, f, h, and j, but the even-numbered bars, 2, 4, 6, 8, are connected respectively to points of the ring diametrically opposite them, bar 2 to the point d, bar 4 to the point g, and so on, each even-numbered bar to a corresponding opposite point of the winding. If now a source of alternating current be interposed between the terminals A^1 and A^2, and we make the single supposition that the ring shall turn through an arc of the circumference equal to that covered by one bar of the collector during each alternation of current, we shall still maintain a constant polarity at the upper and lower points of the ring without causing the brushes to change position mechanically.

Thus a positive impulse starting from A^1 to the left, and indicated by single arrows, enters the ring at b^1, flows down both sides to n, producing the ring polarities s and n, out at brush b^2 and back to source at A^2. The reverse impulse being in the opposite direction will start from A^2 to the right, go to brush b^2, which we will now suppose bearing on segment 4 of the collector, whence it will go by the inverse connection to the opposite point s^1 of the ring, then down both sides in the same direction as before to the point n^1,

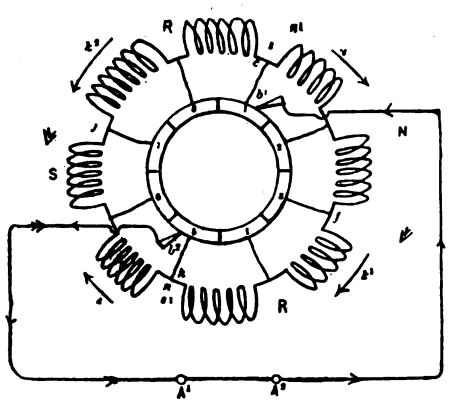

Fig. 1.

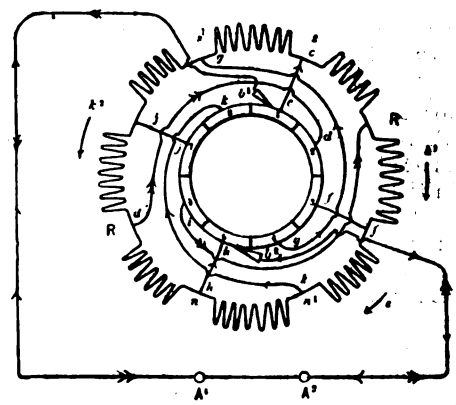

Fig. 2.

* Paper read before the American Institute of Electrical Engineers, New York, September 10, 1889.

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thence back to the opposite segment 8, out at brush b^1 now bearing on this segment, and back to source at A^1.

The reverse currents, therefore, under the assumed conditions, are caused to maintain a constant polarity in the ring, so that in a constant field its tendency to motion would always be in the same direction with an alternating current in the armature. It will be further noted that the alternating current is not re-directed or commuted in the strict sense of the word, and we may enunciate the fundamental principle which underlies the construction of this type of machine as follows :—

"*The poles of any closed circuit may be maintained constant with an alternating current by causing opposite impulses to traverse the circuit in opposite directions.*" The direct and inverse connections shown in Fig. 2 have precisely this effect, when, as supposed, a

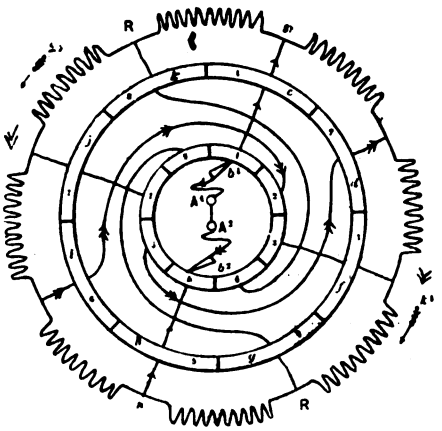

Fig. 3.

single bar of the collector passes under the brushes at each reversal of current. The connections *c c*, *d d*, *f f*, &c., in Fig. 2 may have any form, and other bars may be interposed between their extremities without affecting in any way their functions as connectors. This step is shown in Fig. 3, where another collector bar 1*c*, 2*d*, 3*f*, &c., is inserted in each of the connections *c c*, *d d*, &c., of Fig. 3, thus making another collector, shown outside the first to avoid confusion of the drawing, while for the same reason, the source of alternating current A^1 A^2 is placed inside the inner ring. As the polarities *s* and *n* of the ring are maintained constant as previously described with an alternating current, and current is constant in direction from *s* downward through the right and left halves of the ring to *n*, so must necessarily any current be constant in direction which is led from brushes through any shunt circuit connected to the segments 1*c* and 5*h* of the outer collector ; a field circuit of constant direction may therefore be shunted from this outside

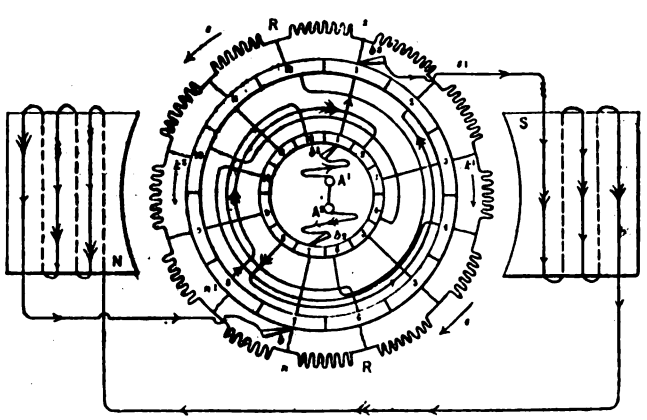

Fig. 4

collector. This is shown in Fig. 4, in which twelve coils are shown in the ring and twelve bars in each collector connected alternately direct and inverse as before. Tracing now two opposite impulses of current, we have the first indicated by the single arrows from source A^1 to segment 1 of the inner collector, thence to segment 1 of outer collector, where the current divides, part going down the right and left-hand halves of the ring to *n*, and part out brush at b^3 through the field circuit, making the poles N and S back to brush b^4 segment 7 of outer and segment 7 of inner collector to the terminal A^2 of source. If the armature be supposed now to turn through the space covered by one collector bar, the reverse impulse can be traced as follows :—Starting at A^2 in the opposite direction to brush b^2 now bearing on segment 8 of the inner collector, thence through the reverse connection to segment 2 of the outer collector, now under brush b^3 where the current divides, going part as before down the right and left halves of the ring, making a south pole at s^1 and a north pole at n^1 as before, and the other part out of the brush b^3 through the field-circuit in the same direction as before back to brush b^4 now on segment 8 of the outer ring, thence through the reverse connection back to segment 2 of the inner ring, now in bearing with brush b^1 and so returning to the source at A^1. Thus the two impulses of opposite direction have been made to traverse both armature and field-circuits in the same direction. We have therefore with an alternating current constant armature polarity, and constant field-polarity, and therefore a constant tendency to motion in the same direction. Not only this, but the further condition is fulfilled that there are no reversals of magnetism in any iron part so long as one bar in the machine, as shown in Fig. 4, passes under the brushes at each alternation of current. It remains to show how this is brought about. Referring again to Fig. 4, let it be supposed that the first impulse of current did not cause the armature to turn through the arc of the circumference subtended by one segment, but all the brushes still bore on the same segments as shown in the figure and the reversals of current continued—by tracing the circuits it will be seen that each reversal of current reverses the polarity of both field and armature, and with either direction of current or rapid reversals, there will be a constant tendency to motion always exerted in the same direction. The machine under these conditions becomes therefore simply a direct-current machine on an alternating-current circuit with a constant tendency to start in one direction. Assuming the machine therefore self-starting, it will continually gain in speed until the condition is fulfilled of one segment passing the brushes at each alternation, for it then becomes in the broad sense a synchronous

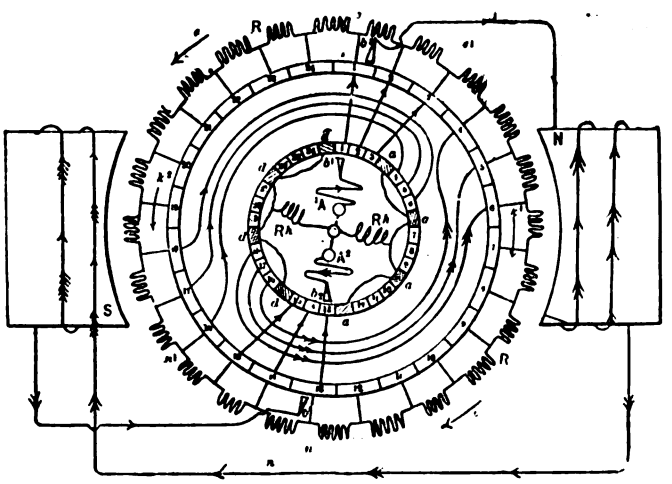

Fig. 5.

alternating motor. The current then produces no reversals of magnetism and there is a true alternating current in the armature circuit—producing however no reversal of armature polarity—and a current of constant direction in the field. Under these conditions the motor is self-regulating, moving at a constant speed and with a maximum rotary effort.

It is not, however, essential that one bar should pass the brush at each alternation, as any number may be caused to do this, depending upon the speed required and the number of coils upon the armature. This is illustrated in Fig. 5, where the complete machine is shown. There are twenty-four coils in the armature, twenty-four bars in the outside collector, and thirty-two bars in the inside one, this latter being composed of twenty-four connecting and eight insulating bars. The connecting bars of the inner ring are numbered to correspond with those of the outer ring around to the right, from one to twenty-four ; the insulating bars, drawn shaded, separate the others into groups of three. In this machine three segments, 1, 2, 3, in the outer ring are connected direct to the corresponding segments, 1, 2, 3, of the inner ring ; likewise the opposite three, 13, 14, 15, of one ring are connected direct to 13, 14, 15 of the other. The next group of three is connected inversely, 4, 5, 6 of the outer ring to the diametrically opposite bars 16, 17, and 18 of the inner ring, and the corresponding opposite group 16, 17, 18 of the outer ring are likewise connected inversely to the diametrically opposite group 4, 5, and 6 of the inner ring. The remaining segments are connected in the same manner, but the connections are omitted to avoid confusion of the drawing. The operation of the machine is evidently the same as that shown in Fig. 4, except that the required conditions are fulfilled in this instance when three bars of the collector pass

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under the ring at each alternation of current; and as there are 24 segments arranged in groups of three, the machine at its normal speed would make one revolution for every eight alternations of current, and connected in a circuit supplied with 16,000 reversals per minute, its normal speed would be $\frac{16000}{8} = 2000$ (two thousand) per minute, and with 48 segments arranged in groups of three, its speed would be 1,000 per minute. The blank segments insulating the groups of the inner ring are connected to the extremities of a Rheostat Rh. Rh., which is enclosed inside the commutator and is designed to offer a path for the alternating current such as there may be, and prevent its absolute rupture at the period of change from one group of segments to the next; they also serve an important purpose in preventing a dangerous short circuit which would be occasioned by the inner brush bridging two groups of segments oppositely connected.

It follows as a matter of course that as the machine starts as a direct-current motor connected in an alternating circuit, rapid reversals of magnetism will at first be produced in all the iron cores, and these should be made of laminated iron to prevent undue loss by heating at the period of starting. The machine, in fact, starts as a direct-current motor, and automatically changes to a sort of synchronously alternating motor. When it gains its normal speed at this point it is self-regulating, and its capacity of doing work is a maximum.

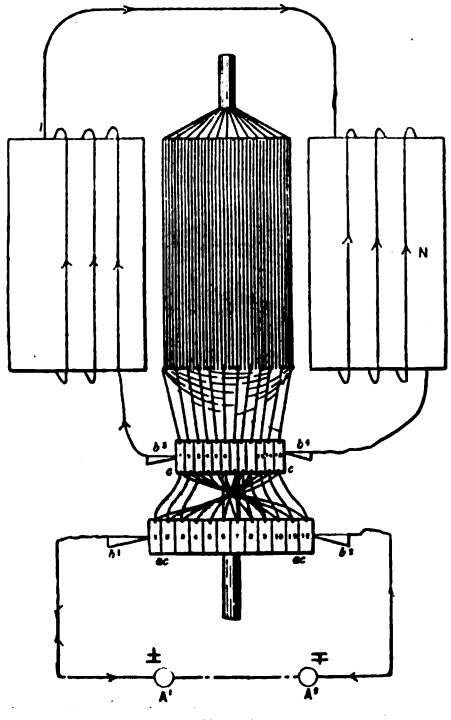

FIG. 6.

Fig. 6 shows a plan of the machine as constructed—it consists simply of an ordinary closed circuit armature in a single field; $c\,c$ is the ordinary collector, really a part of the armature circuit from which the brushes b^3 b^4 take a current of constant direction to the field shunt; $a\,e$ is the reversely connected commutator, and the brushes b^1 b^2 bearing upon this commutator are connected to the terminals of the alternating-current circuit.

I might add to the Paper the fact that the inner commutator, the one which is the ordinary commutator of the Gramme ring winding, does not perform the ordinary functions, as the brushes bearing on this collector require no adjustment, it being a rubbing contact from which the shunt-field circuit is taken as a derivation to the main circuit of the machine. With that exception, I think the machine is fully explained in the Paper.

DISCUSSION.

In replying to the discussion which followed the reading of the Paper,

Lieut. PATTEN said: The sparking being due to the electromotive force at the point of breaking, it will necessarily occur during the starting of such a machine, and more than ordinarily when it is out of synchronism with the alternating current. At the outset it can be easily seen that the alternating current is liable to be broken at a point where this electromotive force is high, and therefore the sparking would be very violent. I have endeavoured to obviate the trouble due to that cause in the machine—the device is shown in Fig. 5. If you will notice the circuits carefully, it will be seen that the circuit of the alternating current is never broken. If the brush comes on to one of the dead segments or shaded segments connected with the rheostat before the alternating wave has come to zero, it finds a path which is at first in parallel with the machine circuits, and then becomes a separate path for the alternating current during its change, whether this change begins at a high or low electromotive force. Of course, as the machine starts, this may happen at any period of the wave, and the brushes passing over these segments connect with the resistance at the end of the group, and before it has left the group the current is already short-circuited through this rheostat, so that the alternating-current always has a path and the sparking will not be excessive, judging from what little experience I have had. It will not start on full load. What he had spoken of as insulating segments are segments not connected with the circuit of the machine, but simply to the rheostat which is shown in the drawing, and this rheostat is intended to take the current at the time the brush leaves the group which is connected with the machine circuits and so prevents sparking. The current is broken when the machine is in synchronism at a point near its zero point. Of course, at 16,000 alternations per minute the interruptions are so short that the field could not readily lose its magnetism, but whenever there is a break in the current, there must be some slight loss due to that.

Mr. MAILLOUX: I should think that a machine of this kind, although it is of great theoretical interest and is an evidence of striking ingenuity, would be open to a defect arising from the fact that the current is a wavy one, no matter how rapid the periodicity is. Then there is always a very short time when there is no current. We may consider that the magnetising current through the shunt is a succession of waves. Consequently there would be an oscillatory tendency in the magnetism, a tendency to rise and fall with it. If the magnetic core is laminated and of soft iron, I think that it will be able to rise and fall quite readily; in other words, quite rapidly enough to follow the fluctuations of the current. We know that it does so in transformers. Of course, there is a slight reaction in the substance of the iron itself—its "viscosity"—due to hysteresis; at the same time, it is not sufficiently great to interfere with the rise and fall of the magnetism, and the more perfectly the core is laminated the more rapidly the rise and fall would take place, also the thinner the laminæ, so that if the magnetic field is made of a very finely-divided magnetic medium, and if the rise and fall can take place readily enough, it seems to me that there would be a certain amount of loss in consequence, which would be quite material under certain conditions, and also a certain amount of loss due to the reactions following from mutual induction in the

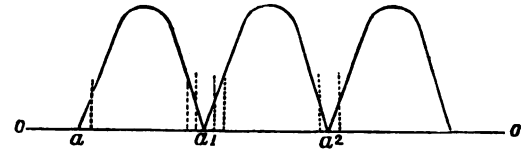

FIG. 7.

armature itself, because we can see that even when running at synchronism the current in the armature would be a succession of rises and falls, and although the magnetism of the armature is not reversed, yet the current is reversed through the coils, and that is not perhaps so disadvantageous as the fact that it is constantly rising and falling at a very rapid rate. I should think that the loss due to mutual induction, particularly in the presence of a magnetic body of permeability and susceptibility, such as the armature core has, would lead to a very important source of loss, and I should not expect that a motor built on that principle would show the efficiency which we might expect from other forms—for instance, as those forms suggested by Leblanc in France, and by Mr. Mordey in England.

Lieut. PATTEN: I have only to say in reply to that, that there is one evident misconception about the direction of current in the armature circuit. It is always the same. As to what has been said with reference to the induction due to the rise and fall of current, such loss is contemplated, and it is difficult to make out of an alternating current anything that does not vary. The essential fact, however, is that the current at work is due not only to the maximum and zero values of the electromotive force exerted, but to the current which is the result of the mean electric force, and that is the electromotive force out of which we desire to get the work. The current is of constant direction in the armature circuit, but it rises and falls as has been said, and the loss due to that has been contemplated. I do not recall any machine described by Leblanc, except those that he has referred to as Mr. Tesla's and Prof. Thomson's earlier form of motor. Beyond them I do not recall any machine in which these difficulties are not equally present. The current in the field will necessarily be a re-directed current. It would be represented graphically in the form I have drawn on the board (Fig. 7). The commuted current at work, or the electromotive force, to speak more strictly, would be cut off at the point a^1 we will say; if the machine is in synchronism at points a^1 and a^2 the interval would be a period of no current. The loss spoken of by Mr. Mailloux will exist during such a slight period of no current whatever, as occurs at the point between here and here. I think that a solid field would not probably give up its magnetism during that short period of time. A closely laminated field might do so.

Mr. LUDWIG GUTMANN: I think the motor just described is very ingenious, but we have, of course, to consider it in connection with the circuit. It is a step forward, because it can be so arranged as to permit the introduction of motors of different speeds on the same circuit. Nevertheless, the motor is of the constant-speed type, while in practice a variable speed is often desirable. The serious objection is that it has the high potential current in the motor armature itself, and in case of any trouble

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arising, the consumer who has to handle it is immediately exposed to the danger of high-tension current in the main wires. Otherwise, I believe it would answer many purposes, because the motor will do its work well. It appears that the motor would not start with any load on it, and would need a loose pulley so as to get up to synchronism before the load could be thrown on. I do not think that this motor can be worked at low tension on account of self-induction. If such a motor should be placed on an ordinary alternating-current circuit of 1,000 to 1,500 volts, and there is any sliding connection and commutators to get loose or brushes to wear out, we should always have to send practical and experienced men to the spot, and they would be exposed to the 1,000-volt current, which would be objectionable.

Lieut. PATTEN: With reference to the high potential, of course, in the general description the source of alternating current is represented as any, of either high or low potential. The current is presumably one of suitable character to meet the conditions in which it is to be used. With reference to the further difficulty mentioned, accidents will happen with any kind of machine, either direct or alternating, while the other forms of motor have some advantage in having ring contacts and sliding brushes that require no attention. The disadvantages that are introduced by bringing in the use of brushes are incident as well to the ordinary forms of motors with which we are familiar. We are not so familiar with the kind that have no commutators that we have got used to their ease and simplicity of working. The second set of brushes are not, as I have said before, brushes in the ordinary sense, and do not require adjustment and care. If a high-potential machine is used, of course the ordinary precautions will have to be taken. It is not quite within the province of the alternating-current motor to make the alternating current safe for everybody who uses it.

Mr. GUTMANN: To produce five to ten horse-power we need a certain number of ampere turns in the field, which entails a considerably higher pressure than might be supposed. We must have an armature to perform the work and to obtain the torque. Consequently I think it is impossible to realise a large amount of power without using medium or high-tension currents for alternating-current motors. I should prefer a motor like Prof. Thomson's, in which the high-tension current is fixed—no rubbing contact; and I think Mr. Tesla has shown us one way in which to construct a motor without commutator or brushes. As it stands, we have increased self-induction, and we need a greater power and greater tension for this class of motor than we would if we had only to energise one of the two parts.

THE RENARD ELECTRIC TABLE LAMP.

The Renard primary battery, which was originally devised with a view of obtaining a light battery for driving the electric motors in connection with the Renard-Krebs dirigible balloon, is now being used for domestic lighting purposes, and it was recently employed to supply current to the arc and incandescent lamps lighting the rooms at the Société d'Encouragement on the occasion of the joint meeting of the Institution of Electrical Engineers and of the Société Internationale des Électriciens. The negative element of the Renard battery is platinised silver foil shaped into a tube, in the centre of which the zinc rod is placed. The liquid is a solution of chromic acid, hydrochloric acid, and sulphuric acid, and is contained, as a rule, in glass tube-like cells. The spent liquid, it may be mentioned, is a powerful disinfectant.

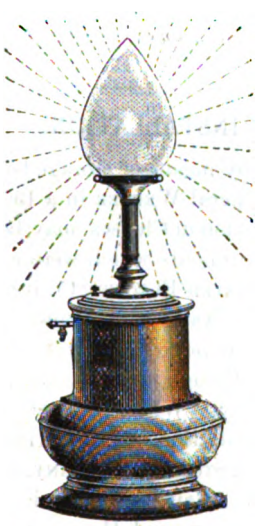

FIG. 1.

A 25-candle lamp, weighing 35lb. and containing a sufficient charge for from five to eight hours, is shown in Fig. 1. The battery consists of seven Renard elements connected in series, and it is capable of giving a current of 4 amperes at 11 volts for the above-mentioned period. In order to charge the battery the candelabrum is removed, and the seven zincs are placed in their respective apertures on the vulcanite lid and screwed up; the solution is then poured into the reservoir by the remaining aperture, and the candelabrum is replaced. The liquid is driven from the reservoir into the cells by means of the india-rubber ball p (Fig. 2), the stopper b being previously screwed down, and the tap r opened. When the light is no longer required the air in the reservoir is allowed to escape, and the liquid falls clear of the zincs. To empty the spent solution the candelabrum is taken off, the zincs removed, and the liquid is pumped into a glass jar by means of the aspirator p (Fig. 2).

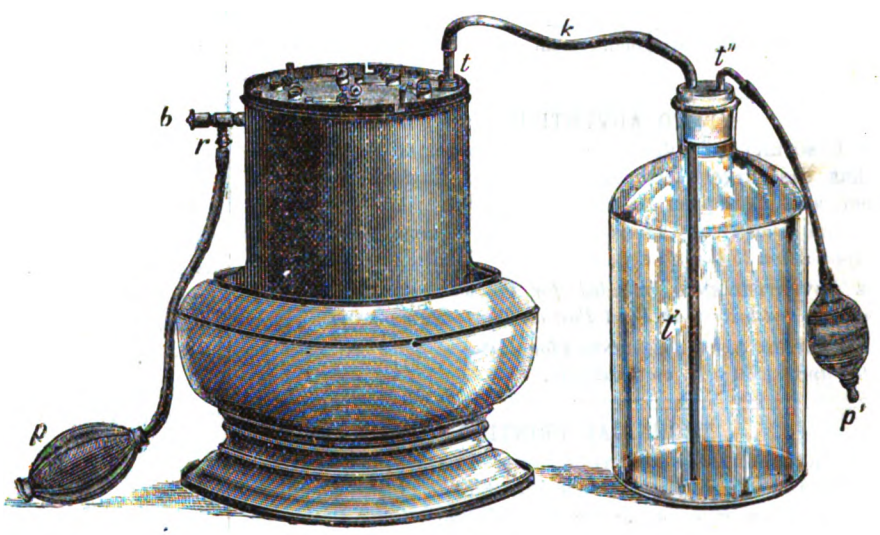

FIG. 2.

The composition of the liquid for one charge is as follows:—Water 5¼ pints, muriatic acid ·7 pints (400 cub. cms.), sulphuric acid ·67 pints (380 cub. cms.), chromic acid 2lb. 7oz. The price of these ingredients is about two shillings, so that the cost of the candle-hour may be taken at about one farthing.

This lamp, which is sold in this country by Aron Brothers, of Bridewell-place, seems to possess several advantages over many of the domestic electric lamps hitherto in use. The cleansing operations are reduced to a minimum, owing to the absence of crystal deposits, and the difficulties of mounting and unmounting, which act as such formidable deterrents to the employment of primary batteries, have been largely overcome. The acids employed are, moreover, such as are easily obtainable in the ordinary way.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To-night) FRIDAY, October 11th.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Inaugural Meeting of the Ninth Session of the Society at the Westminster Palace Hotel. Presidential Address on "Mechanical Engineering in Electrical Industries." By Prof. JOHN PERRY, D.Sc., F.R.S.

SATURDAY, October 12th.

CITY AND GUILDS OF LONDON INSTITUTE OLD STUDENTS' ASSOCIATION.

7 p.m. Fifth Annual Dinner at the Manchester Hotel, Aldersgate-street.

TUESDAY, October 15th.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "King Frost." By ARTHUR CLAYDEN.

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The Electrician.

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THE CHELSEA INSTALLATION.

The system of distribution by means of storage-battery sub-stations, described by Major-General WEBBER in a British Association Paper, and now in operation in Chelsea, may be regarded as the final outcome of the experiments which were commenced on a large scale by the CONSOLIDATED ELECTRIC COMPANY at Colchester in the spring of 1884. As is well known, this early attempt, from which so much was hoped at the time, resulted in failure; but the experiment, though a costly one, proved not to have been wholly thrown away. When in 1886 it became necessary to abandon the installation, Mr. F. KING and the officers of the ELECTRICAL POWER STORAGE COMPANY, with whom he has since been associated, retained a firm belief in the inherent soundness of the scheme, and they devoted much of their attention to its improvement in points of detail. It was early perceived that the "sweet simplicity" of the single "rock-over" switch which had been deemed sufficient at Colchester could never fulfil all the conditions which are imposed by the practical working of such a system of distribution, and the number of supplementary devices found necessary was gradually augmented until the highly complex organism described by General WEBBER had been evolved. It is impossible to deny that these complicated automatic appliances—much as we admire the ingenuity displayed in their design—do form a weak point in the system. Whether the weakness is such as to prove any serious obstacle to its progress, time alone can show. We sincerely trust that it will be found that these appliances are as successful in operation as they are admittedly skilful in conception.

It will now be interesting to note the chief points of difference between the Colchester installation of 1884 and the Chelsea installation of 1889. First, there is the improvement in the batteries to be noted; the batteries used at Colchester were

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made by the CONSOLIDATED ELECTRIC COMPANY, and were of the Planté type. The plates were made up of thin strips of lead, pressed or coiled together, and having a thicker tape coiled round them, the whole being burnt together at the corners to obtain the necessary rigidity. With this type of cell it was impossible to obtain that uniformity of structure throughout the battery which is so essential to its preservation. To make matters worse, the insulation of the Colchester cells was badly arranged. The cells were supported on cast-iron racks, resting on porcelain insulators, which latter rested on the bare floor. The modern method of mounting cells is by means of oil insulators, resting on wooden racks, which at Chelsea are supported on cast-iron standards. We need not refer in detail to the difference between the Consolidated cell of 1884 and the E.P.S. 1888 type, the latter being already so well known. Perhaps the chief practical advantages lie in the large clearance which is now left between the lower edge of the plate and the bottom of the cell, and above all in the uniformity now attained in the manufacture. In capacity for discharging a heavy current for a short period without suffering damage, some advance has also been made, and of course the care of cells is now better understood.

An important distinction betwixt the two methods lies in the fact that whereas in Colchester two complete batteries, each capable of supplying the entire output, were employed, at Chelsea there is only one battery, divided into two halves, each half being charged at different times during the hours of daylight, and used in parallel during the period of maximum demand.

Turning next to the method of operating the automatic switches, we find that the principle remains unaltered. In each case, towards the close of the charge, a "master cell," whose evolved hydrogen has been collected in a small gasometer, is entrusted with full responsibility. In the earlier case, however, the pressure of the gas merely operated a plunger, closed a local relay, and over went the rocking-switch with its thirty-six mercury contacts, reversing the connections of the two batteries, the newly-charged battery being put on the supply circuit, and the second taking the place of the first on the charging mains. Now, we are not aware that any complete account of this switch and its exact method of operation has ever been made public. There is a long verbal description by Mr. KING in *The Electrician* of June 14th, 1884, but it does not tell all we should like to know. It is, however, sufficiently evident that this apparently quite sudden breakage of a 2,000-volt circuit was a ticklish thing to deal with. We do know that these switches proved a serious source of trouble, and we expect that the dynamos—although it is true that they were separately excited—also suffered. Now for the Chelsea device. The whole operation, although perfectly automatic, is effected with deliberation, requiring one minute to complete itself. First a separate resistance, taking a current equal to that of the half-battery, is switched in parallel with it; at the same time half-battery No. 1, now fully charged, is switched on to the supply circuit in parallel with half-battery No. 2. Next the latter is put in parallel with the resistance on the charging mains, and finally the resistance is withdrawn. In these operations several solenoids or electro-magnets fulfilling different purposes come into play, and a relay transmits a current by a special wire to the generating station, and at the critical point cuts off steam from the engine. How this affects the other storage stations, which we take it may or may not some day chance to be in another stage of the same series of operations, we are not told, and it seems rather a formidable problem to work out on paper. We should also like to have more information than we at present possess as to the arrangements adopted in the dynamo room.

As to the regulation of the E.M.F. on the house mains at Colchester, so far as our information goes, no special precautions were taken, but at Chelsea we have a set of four counter-E.M.F. cells with their accompanying tell-tale wires, and automatic switching appliances by which this important matter is looked after. The details of this part of the apparatus are again very complex. We find a fine wire coil in parallel with the feeders, actuating a relay which causes "two double-acting solenoids" to operate switches which traverse sliding contacts connected with resistance coils. Then there is an ingenious "E.M.F. governor," with a temperature compensator containing mercury and alcohol, and so on.

At Colchester we have already noted that the battery was switched on or off the supply circuit as a whole, whilst at Chelsea one half-battery is on in the daytime, whilst the two halves are in parallel during the hours of maximum demand. General WEBBER does not seem to have explained the *modus operandi* whereby the second half-battery is brought into parallel with the first, when the increased output renders the step necessary; but doubtless there is an appropriate set of automatic jacks-in-the-box dedicated to this task. Then, again, there are the continuous-current transformers which are to be brought into play (automatically, we presume) when the growth of the system demands a still greater output. Perhaps all this is included in the "many minor very important and interesting features" which the gallant General, for want of space, was unable to describe.

It is abundantly evident that this system has had bestowed upon it an amount of, we had almost said, loving care and ingenuity which at least deserves, as we trust it will command, success. But if this should unhappily not be the case, it would seem probable that Chelsea will perish under the weight of excessive elaboration, as Colchester fell a victim to its undue simplicity.

DISTRIBUTION OF ELECTRICITY IN CHELSEA, &c., WITH ACCUMULATORS AS THE MAIN SOURCE OF SUPPLY.*

BY MAJOR-GENERAL WEBBER, C.B.

Accumulation of electricity is the first necessity to those who study the conditions of its supply to consumers living in a thickly-peopled district, and has been so since the notion of distribution to an inhabited area from a centre of generation has taken a practical form. In face of the many cases in which distribution has been undertaken without accumulation, this may be regarded as a bold statement. But I can only say that I have not met one who, having adopted it, does not candidly admit that the advantages of the presence of means of accumulation are undeniable. The financial question has governed the advance of the industry, and the scattered nature of the first demands for a supply of electricity has without doubt led to the adoption of high-pressure distribution when every other consideration would have appeared to suggest that all first attempts should have been made at low pressure. The insulation afforded by the use of aerial conductors has led to partial success. If the distribution had had to be carried out by underground mains from the first, the deterrent effects of the experience that would then have had to be gained might have led to different procedure, and even the financial aspect of the question might have gone through different phases. Some will assert that the industry in this country could not have made a start at all, in the face of cheap lighting gas, if it had not been pioneered by means of economical conductors, however temporary, and without attempting to accumulate. But, after all, it was only a question of cost, and it is certain that had the capital been forthcoming in 1886, it would have been as easy to have obtained success with the system I am about to describe as now. All the essential means now at our disposal, except matters of minor detail, were then equally at hand. This is proved by the fact that the proposals prepared and made in 1886, immediately after the Chelsea

* Paper read before the British Association in Section G, Newcastle, September, 1889.

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Provisional Order was approved by Parliament, are similar to those which have been carried out in 1889. It was as clear then that accumulation and distribution underground was the true solution of the problem for a comparatively densely-populated district.

The district of Chelsea was selected, not as the wealthiest or most densely populated, but because it was destined then, and since then, and for some time to come, to be one in which the dwellings are in a process of reconstruction. It was in 1886 as evident as it is now that the impediments in the way of getting old houses wired is a serious hindrance to the rapid spread of the demand for current, and that this impediment is minimised under that condition. In the interval many of us have been fascinated by the high-pressure systems. I think myself fortunate that, I may say, accident prevented me attaching myself to any scheme dependent on that condition, together with alternating currents, for domestic supply. The temptation was rather strong for one reason at least—that is, that some capital was forthcoming to promote the latter, while very little could be got together to carry out the former plan. Although it is not sound, the engineer sometimes *does* surrender his better judgment when money leads.

The Chelsea system may be described in the following terms:—Accumulation of the main supply from a generating station in storage stations, situated at suitable distances from one another, combined with the following—

(*a*) Charging the accumulators at high pressure, and discharging for distribution at low pressure, and effecting the changes necessary to the same by special automatic arrangements placed in each storage station.

(*b*) Supplementing the main supply by means of continuous-current transformers.

(*c*) Distributing by means of mains laid down in a network.

(*d*) Maintaining a constant pressure by means of the introduction into the discharge circuit of counter E.M.F. cells, and by means of feeding points judiciously placed intermediate between the storage stations.

(*e*) The use of underground conductors throughout, laid so that the cables can be drawn in and out, and renewed or repaired whenever necessary, without disturbing the ground.

It has been remarked that one of the causes of interference with the spread of the use of electric light is the outlay entailed by the necessity to introduce conductors and fittings for distribution and consumption within the house. Members of a society called the Dynamicables will remember a Paper on this subject, read a few years ago by Mr. Crompton, when he expressed a hope that the cost of such work might be brought down to 15s., without including the lamps and their fittings, for each point where the light is required.

The fact that this figure has rarely been realised, and more often doubled, is not, however, the chief impediment. It has been suggested that the undertakers might carry out the work on a deferred payment system, but this would meet only a limited number of cases. The main cause of impediment at present is the condition of the situation as regards landlord and tenant, by which there is no inducement to the former to do more for his tenant than his lease obliges him to do, and by which there is no compensation to an outgoing tenant for outlay on *bonâ fide* improvements. The fitting up of houses for gas consumption has now, by competition, been brought down to about 7s. for each point where a burner has to be fixed, above a certain minimum number of points. Except under Government Departments, I have rarely encountered any form of specification for such work. I have never yet heard of gas engineers being called in to advise on or pass work for the distribution and consumption of gas inside buildings, beyond questions of meterage and regulation of pressure. The consequence is that the proportion of gas which from one cause or another escapes unburnt, and enters into combination with the air we breathe, is very considerable in proportion with the gas we actually use to give us light, varying from one or two to seven or eight per cent., some due to defects in pipes, more to defective burners. For economy, the same work in connection with electric lighting is rapidly tending to fall into a similar condition, and were it not for the practical necessity to take precautions to protect buildings from fire risk, and the public from injury to person, which has given rise to Fire Insurance and Board of Trade rules, the consumers of electric current ere long would find themselves in a worse condition than if they stuck to gas as an illuminant, for reasons in connection with leakage which are evident to all my hearers without any description.

In Chelsea we have from the first endeavoured to counteract this evil by, first, holding aloof from all appearance of having any pecuniary interest in the work of fitting up houses in the area of supply; second, supplying to the inhabitants, either free of cost or for a small fee, a copy of our standard specification for such work. This form is compiled so that it can be used under varying conditions when filled in by a competent engineer. A sample of it is attached to this communication. The necessity for care and precaution in this respect, and the consequence of a little more trouble and expenditure to the public than has hitherto been given to the subject of lighting, is, however, well repaid by the advantages to health and comfort by adopting electricity as an illuminant. This is the sole lever with which electric light undertakers have to work in face of—

1. Competition with cheaper illuminants, which in the case of mineral oils are one-third to one-fourth the price of electricity, light for light, both as regards first and annual cost.

2. Indifference to the question of health so long as the danger is not very apparent, only being very slowly counteracted by the spread of knowledge.

3. Rules and regulations which everyone acknowledges to be salutary, but which must hamper the industry at first, particularly so as the rival illuminants are not subject to anything of a similar kind.

The apostles of electricity as an illuminant have, however, no fear that sooner or later it must triumph, and that the poor as well as the rich will eventually enjoy its advantages; and that those who have given labour and attention of the most exceptional nature to produce perfection will eventually reap their reward.

Leaving this branch of the subject of consumption, it should be stated, *en route*, that the meters in use in Chelsea are those of Aron, Chamberlain and Hookham, and of the Brush Company. The first, which is used in this country under a royalty from Messrs. Ayrton and Perry, and which is at present in a large majority, has undergone considerable modification and improvement in construction lately, with the result of greatly simplifying its action. The meter as now employed has no starting gear as formerly, to which objection had been found to exist. The meter is compact, being about 2ft. 5in. long by 15in. wide and 8in. deep. It is constructed of two sets of clockwork, the deviations of which are to be indicated, mounted side by side in the same frame with a differential counter placed between the two sets of clockwork. The clockwork is driven by a spring. The differential counter consists of two crown wheels, having at the same time a cylindrical gear opposite each other. Between the crown wheels a planet wheel is arranged gearing with both the crown wheels, and is made so as to turn at the same time round its own centre, and so as to roll along the cylindrical gear of the crown wheels, and it is balanced by a counter-weight. The vibrations of a pendulum of one of the sets of clockwork is either accelerated or slackened by the influence of a coil through which the whole of the supply current passes; the pendulum has a permanent magnet or armature attached to its end, and is so arranged as to swing immediately over the centre of the coil. The clockwork being synchronised, there is no movement of the indices on the dials when no electric current is passing, although the clockwork is running continuously. The clockwork runs for six weeks, but we find it advisable to wind them once every month to ensure them from accidental running down before their time, and thus stopping their use for registering. They are easily fixed in position by a workman. It is only necessary that care should be taken to set the pendulums so that they hang immediately over the setting pin placed for the purpose. The man then winds the meter, starts the pendulums swinging, and the meter is then ready for work and for the purpose of recording when the electric supply is started. These meters have given most satisfactory results during the six months we have had them in use. The meter registers in ampere-hours, *i.e.*, each unit registered by the index dial has to be multiplied by a constant supplied with each instrument. For the convenience of customers, a multiplier is supplied by us with each meter card, and instructions printed stating that the amount registered by the indices at any time multiplied by the multiplier given on the card enables them to ascertain in Board of Trade units the consumption of current. The meter of Messrs. Chamberlain and Hookham has been so thoroughly described this year by Mr. Hookham before the Institution of Electrical Engineers that I need not give any of its details. Our experience of its working is at present very limited.

The Brush Company's meter (Fig. 1) may be described as follows: The meter consists of, *a*, an electrically-driven pendulum, suspended over an electro-magnet, a_1, but slightly at one side of it. Near the pendulum is placed, vertically, a solenoid, *b*, in circuit with one of the conductors to the lamps; the core is carried by a light rod attached to a spiral spring suspended from above. To the side of the rod towards the pendulum is fixed, in the plane of oscillation, a notched integrating plate, *c*. As the core is drawn down by the current passing through the solenoid, or lifted up again by the spring, the notched plate is also raised and lowered. An horizontal arm, *d*, resting on two rollers, travels backwards and forwards with the movement of the pendulum, but the distance travelled, or amplitude, is controlled by the notched plate, being greatest when the core is drawn down so that the horizontal arm travels as far as the uppermost notch, and smallest when the core is elevated so that the arm is stopped by the notch on the edge of the widest part of the plate. The arm carries a small catch, which, when it travels to the left, drawn thither by the spiral spring at that end, pushes round the last and lowest wheel of the counting gear, *f*. For instance, when the arm moves through the shortest distance the

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wheel is pushed round only one notch. This smallest movement may be regulated to occur when one-third of an ampere is passing through the solenoid, and thus accurate metering is ensured by the construction of the parts being such that for each sway of the pendulum the last wheel of the gear is always advanced through an angle exactly proportional to the current flowing at the moment. The electro-magnet, a_1, used for driving the pendulum is on a shunt from the supply main, the circuit of which is closed and opened by a relay, e, which comes into action with the smallest current that the meter is required to measure. I have described the main features of this apparatus only, but there are other minor ones; for instance, a contact-making device worked by the pendulum for the purpose of properly timing the impulses given to the electro-magnet (a_1), with which I will not occupy the meeting.

A marked feature in the system of distribution by continuous-current at low pressure is the absence of the transformer from the premises of customers, and the small space required in the house for the meter and cut-outs. Although the space required for a transformer is not theoretically large, in practice it is found that its installation is a more serious cause of expenditure and interference with structure than the advocates of its use lead us to suppose. In very few houses is to be found a chamber suitable to receive a transformer of ordinary size. In 1887 I inspected one of the first installations

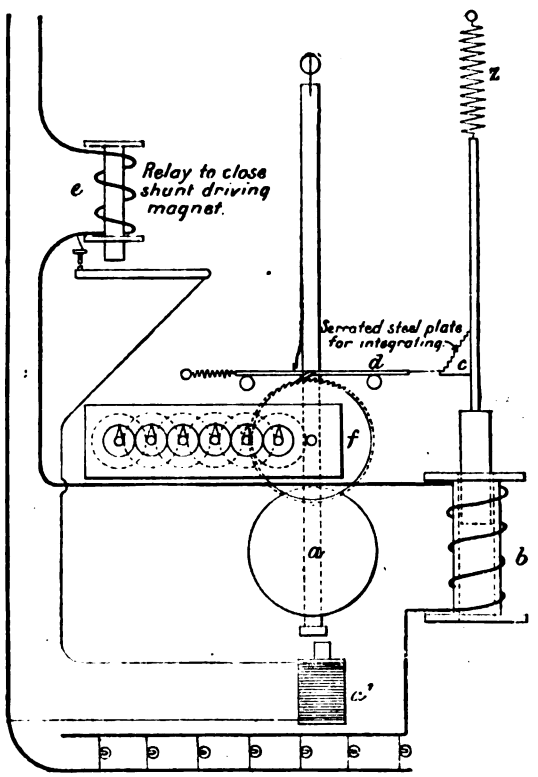

FIG. 1.—Diagram of Brush Company's Meter used at Chelsea.

under the system, namely, at Lucerne, by Ganz and Co. There I found the transformers in cupboards, and heating so as to colour the surrounding woodwork. The insurance companies in England would not have permitted them to remain a day in such a place. It is wrong to suggest that the installation of a transformer does not entail an expenditure much in excess of its actual cost. This condition affects materially the comparison between the first cost of rival systems.

We now come to the work outside the customers' premises, and I am able to show you a diagram illustrative of this part of the distribution. The area (Fig. 2) comprises portions of the parishes of Chelsea and Kensington. Its superficies contain about 867,000 square yards, or about 1/3·5 of a square mile. This area, divided into storage areas, in each of which a storage station is, or being, placed, allows to each such sub-area a space represented by a square of 415 yards a side. The generating station is marked X, and in the same building is placed a storage station. The other storage stations are marked O. Of these there are five in all. The points to which feeders are taken are each marked +, with letters to most of them. Each storage station itself is also a feeding or E.M.F. point. At present, the feeders vary in section between 61/12 and 37/13, according to the length and the current it is estimated they will be called on to conduct. The distributing mains, which are laid so as to supply the houses in every street prescribed by the Act as compulsory, sometimes in front and in some places at the back, connect all the E.M.F. or feeding points, and vary in sections between 37/13 and 19/16. The pilot wires from the storage stations to the generating stations, and from the E.M.F. points to the regulators in the storage stations, are of small section, and have their separate "ways" in the conduits or cases. All the "ways" can receive cables of larger dimensions, so that the section, when necessary, can be increased. And, besides, in each line of conduits spare "ways" are provided for future use. Up to the present time, about 10,575 yards of cable have been drawn in and put to use, besides some thousands of yards of pilot wires. By the end of this year these figures will be increased more than half as much again. The joints in the E.M.F. boxes, between the feeders and the distributing systems, are made by soldering the cables to a copper jointing piece, made as shown in the diagrams (Fig. 3) on the blackboard. All cables, after being drawn in and before being jointed, must show an infinity insulation resistance test before being passed. The test is made at a pressure of 100 volts. In many instances, after joining up sections of the network, and testing them together, including joints of house services, the disconnected ends sealed, the same result has been obtained.

The question of the cost of the mains and house connections is one which forms a most important factor in the undertaking. After careful consideration of the subject from all aspects, the use of bare copper conductors was discarded. With the permission of the War Office, experiments had been made by me at Pimlico with bare copper conductors so long ago as 1884. In making the tests I had the kind assistance of Prof. Ayrton, F.R.S. The conductors were made of uncovered copper wire cables, I think 19/12. They laid in notches made in insulite saddles seated in cast-iron troughing 6ft. long, jointed end to end, and having covers also carefully jointed; the cables were free of all approach to contact with the surrounding iron, and all the joints of the iron casing were watertight, or believed to be so. Tests were made with a 50-ampere current at an E.M.F. of 80 volts at intervals of some months after the wire was laid underground, and it was tested under the two conditions of having the intervals around the cables left vacant, and

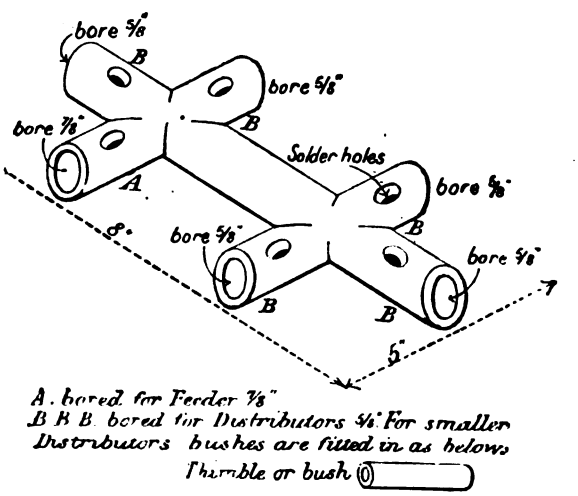

FIG. 3.—Copper Jointing-Piece for Mains.

filled in with paraffin wax. The results led to the complete abandonment of the plan, and of the patent which had been taken out for it. There is a strong resemblance between it and the mains which are being now laid down in the district in London known as the St. James's. For the sake of the industry, in which so many are interested, I trust that those responsible for that work will meet with greater success than I did. Experiments were made in 1886 and 1887 with the view to obtain some form of conduit which afforded a separate "way" for each insulated flexible cable; and so that the old and well-known *drawing in and out* system of the Electric and International Telegraph Company, founded on an experience of many years, might be followed. A metal tube for each cable was too costly. The bundle of cables in one iron pipe would prevent the possibility of drawing in and out. The material of bitumen concrete, which could be moulded to any form, presented itself, and the patent of Butler as to the mixture was followed. The Callender Bitumen Company undertook to carry out the work, and a sample line of casing and cable drawn in was laid, and was under trial during the period of one year at the Borough-road premises of the Anglo-American Brush Electric Light Corporation. Out of this has grown what has become known as the Callender-Webber system, descriptions of which have been given elsewhere. All that was anticipated of its advantages have been more than realised in Chelsea.

Although the part of Chelsea in which operations were carried on should present the fewest difficulties to be encountered in any part

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of London, it was found that there was little or no local knowledge as to the size or position of the cellars of houses, and that no one could tell where the arches stood, or where the water and gas mains and services actually lay. As the access to house-service boxes must be easier if the main is in the footway than if it is in the roadway, every effort was made to keep within the edge of the kerb. But to do this in many places was found at first to be impossible, and the cases had, in several places, to be laid under the roadway. In such a position it was necessary to keep them outside the gas and water mains, and as the local authority prescribes a minimum distance of 3½ft. between these mains and the kerb, and 1½ft. between mains themselves, it followed that those for the electric light had to be 8ft. or 9ft. from the kerb. The future inconveniences arising from this are so many that it has now been decided never to lay the "cases" anywhere under the roadways, except at crossings, unless absolutely physically impossible to do so. The material of which the "cases" are made lends itself to this, as it can be made in flat sections, with a single tier of holes, O O O, and in such a form occupies very little space in depth. The facility of bending it is also a great aid in passing obstacles. There *have* been instances in which we have been able to get in "*casing*" in advance of the services of the gas and water companies, and in those we calculate that the cost is reduced at least 10 per cent. The great ease with which the material of which the casing is made can be cut simplifies the operation of inserting a house-service box on the mains that have been previously laid. Only that portion of the case need be removed which contains the ways in which lie the distributing mains. The box is best formed of brick in cement, and the top of cast iron, with a waterproof cover flush with the footway. The same manner of construction has been found best for draw-boxes, the iron tops of which are either L or T shape, also the E.M.F. boxes, where the feeders terminate. In the latter case the ordinary street manhole cast-iron top has been found to answer very well the purposes of a cover. Practice shows that if the sides and bottoms of the box were also made of iron, a great variety of patterns would be required, as the conditions vary at every point, so that brick in cement for all these boxes is the best material. A specification of the manner of conducting the work is in use, and a copy of it is attached to this communication. If care and attention is given to the simple rules for laying the casing, no difficulty is encountered with the cables. A true and smooth way is provided for each, so much so that in rare cases of need from one cause or another no difficulty has been found in pushing through from box to box one of those screw-jointed rods used by sewer men or chimney sweeps.

It will be gathered from the features of the system I have referred to that considerable economy in excavation can be secured by its adoption, in actual cost of the "ways" for the cables, totally avoiding the need for special castings for bends, and also in all the operations of branching-off and jointing. In comparison with the bare copper systems, the saving in towns in the cost of removing the soil to make space for the conduits is very considerable. Of the durability of the material, resistance to strains, and conditions of temperature, so far the proofs have been very satisfactory. But, as I have already stated, its foremost advantage is that it enables us to comply with the fundamental conditions of successful maintenance by permitting of the easy and rapid removal of faulty sections of cable, and the renewal of the same. Under such circumstances, with low-pressure distribution, a high standard of insulation resistance may be dispensed with, and a further saving in outlay effected. For let it be remembered that failures of the insulation of underground distributors of electricity will not occur by the gradual deterioration of the dielectric throughout its length, but by the existence of exceptional causes for its decay at isolated and unexpected points. Although the substance of which the Callender-Webber casing is made is dielectric, yet no reliance is placed on it even as an assistant to the insulation. The slight porosity of the material, and the

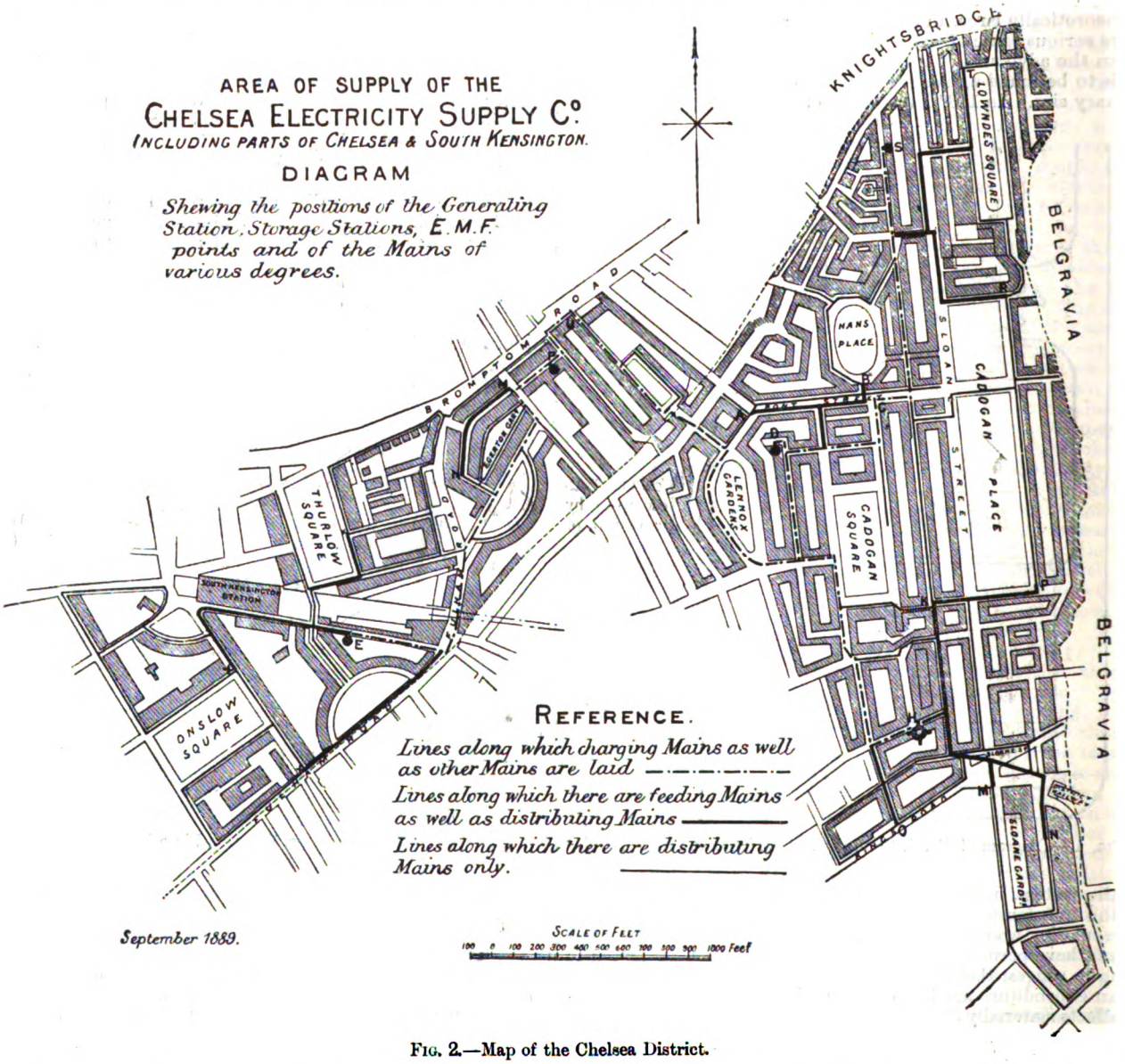
AREA OF SUPPLY OF THE
CHELSEA ELECTRICITY SUPPLY Co.
INCLUDING PARTS OF CHELSEA & SOUTH KENSINGTON.
DIAGRAM
Shewing the positions of the Generating Station, Storage Stations, E.M.F. points and of the Mains of various degrees.
KNIGHTSBRIDGE
BELGRAVIA
BROMPTON ROAD
THURLOW SQUARE
ONSLOW SQUARE
SOUTH KENSINGTON STATION
LOWNDES SQUARE
HANS PLACE
SLOAN STREET
CADOGAN PLACE
CADOGAN SQUARE
LENNOX GARDENS
SLOANE GARDENS
REFERENCE.
Lines along which charging Mains as well as other Mains are laid
Lines along which there are feeding Mains as well as distributing Mains
Lines along which there are distributing Mains only.
September 1889.
SCALE OF FEET
100 0 100 200 300 400 500 600 700 800 900 1000 Feet

FIG. 2.—Map of the Chelsea District.

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impossibility of making an absolutely watertight joint at every point where the lengths are united, at present precludes the idea of complete exclusion of moisture. It will be seen that this system lends itself to the manner of distribution already described by bringing within the range of practical experience the provision of the necessary number of "ways" for charging, feeding, and distributing mains, all of which along the same route may be lying contiguous to one another. The reference to it forms part of the description leading up to an examination of the basis of the system of distribution, in which accumulation constitutes the chief source of supply, and not a mere auxiliary. In such a system the generating station is even subordinate to the storage stations.

Given an area, and having determined what may be called (1) the active demand, and (2) the possible ultimate demand, and having decided to provide for the first, with the power to meet the second at some future date, the first thing is to lay it out in storage dis-

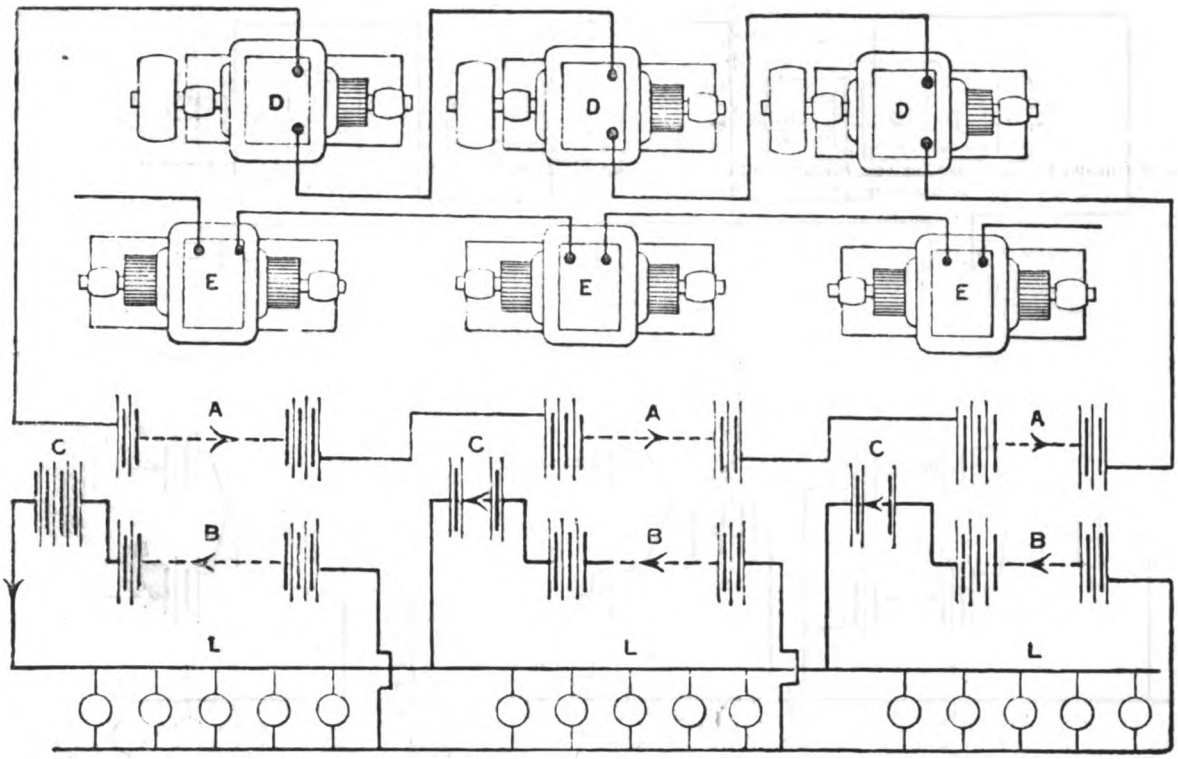

FIG. 4.—Arrangement 1. Dynamos charging First Half of Batteries.

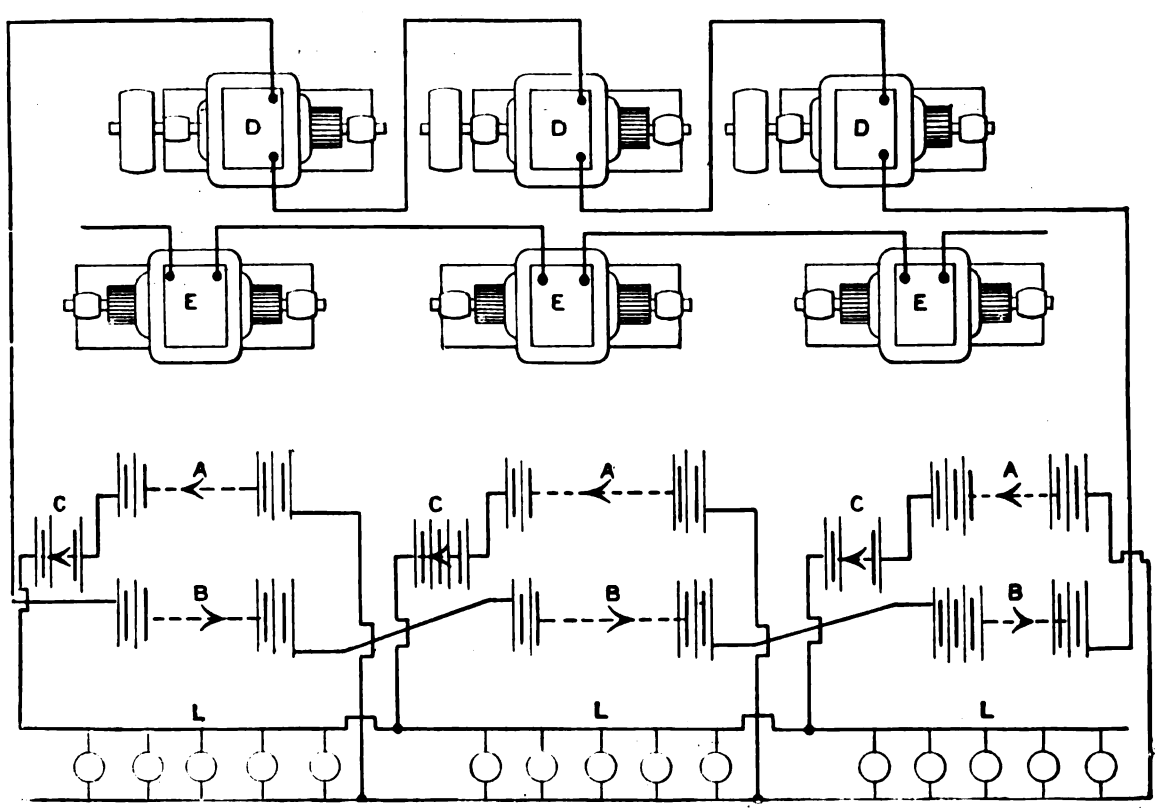

FIG. 5.—Arrangement 2. Dynamos charging Second Half of Batteries.

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tricts, always subject to the power of securing sites, and next, to fix the positions of the points to which feeders should be carried.

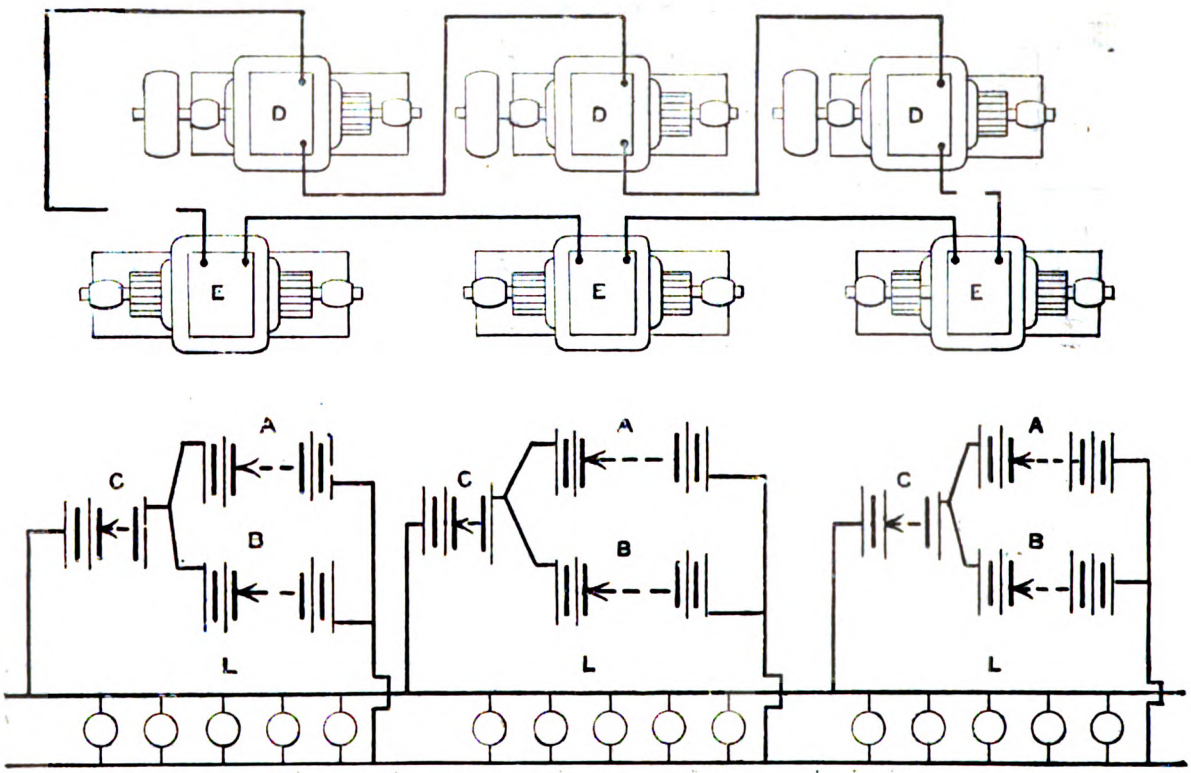

FIG. 6.—Arrangement 3. The Two Batteries Discharging in Parallel.

This would be a difficult thing were it not for the elasticity afforded by the network system, and by the power of varying the section of copper in the mains, which is simplified by the use of "ways."

one-third, or 70 of these. The distribution being at a pressure of 100 volts in the distributing mains, or 106 to 108 volts in the feeders at the station, a discharge of 600 amperes, to give 530 effective at the lamps, allows an ample margin, and this is afforded by the two half batteries in each storage station discharging at the same time.

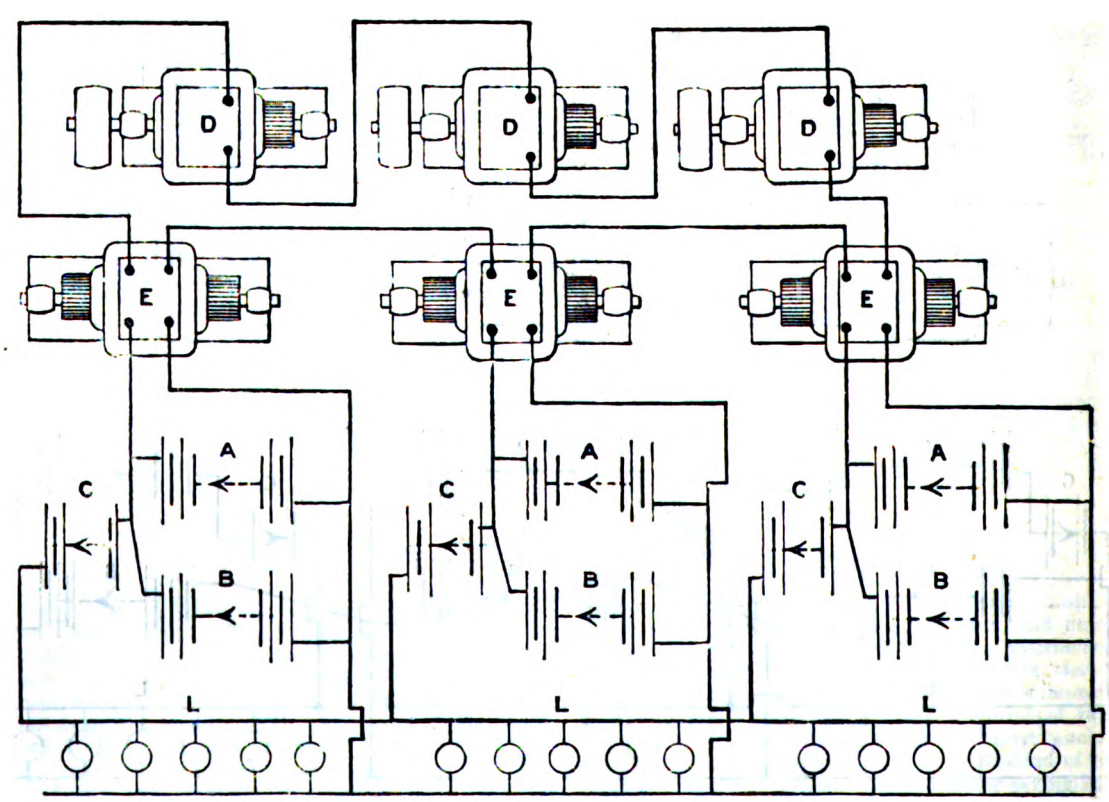

FIG. 7.—Arrangement 4. Continuous Current Transformers in Parallel with both Halves of Battery.

Our estimate in Chelsea to meet the "active demand" has been to establish one storage station to each 210 shops or residences, and to provide capacity for 27 30-watt lamps being in use at one time in

Each half battery consists of four sets of 54 L 31 1888 type E.P.S. cells, or a total of 432 cells. On exceptional occasions, one of these stations may be required to discharge at the rate of 800 amperes,

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and will do so without injury to the cells. Although 1890 lamps are estimated for, the capacity of the station is for a normal 2,000 lamps, and, as has been stated, for an exceptional maximum of 2,500. The possible ultimate demand is a thing that I believe no one at present can estimate. Of course, any of us may make the statement that every dwelling *must* take the electric light, and that it *must* come, and it is easy to sneer at any scheme which does not now provide for such an end; but from the actual experience I have had, it is clear to me that the question is still rather obscure, and that end still far off. Meantime the Chelsea system provides for an increased capacity of 50 per cent. on the normal of 2,000 lamps—*i.e.*, up to 3,000 lamps—by the use at each storage station of a continuous-current transformer which will be put to work and yield its whole output during part of the time of maximum discharge, namely, between six and nine p.m. To those who put capital into the undertaking of electric lighting, it will be of interest to know that the calculations made on the basis of one-third of the houses requiring the light in five such areas as have been mentioned, and in the proportion named, show an excellent return on the investment. I only allude casually to this point, as the financial calculations of the subject do not enter into the scope of a communication to the Association.

I now arrive at the part of my subject when it is necessary to refer to the installation of the *storage stations*, and to state that, beyond a reference to the capacity of the generating and charging unit, I do not propose to give any description of the generating station, which, by the way, I do not refer to under the usual term of *central station*, as it need not be placed in any way centrally with reference to the group of storage stations for which it is required to generate charging currents. These charging currents are given by separate engine and dynamo plants, one for each station; in the case of Chelsea, 75 horse-power Willans and Robinson's well-known engines, and 37½ unit Victoria Brush dynamos, which are capable of giving a current of 75 amperes at 500 volts. The diagrams represent:—First (Fig. 4), three of these plants in series charging one of the half batteries in each of three storage stations, the lighting being maintained by the other, or second half battery; and the pressure in the distributing mains being regulated by cells which give a counter E.M.F. In the second (Fig. 5), the three plants are shown charging the second half batteries—those which having been previously charging, are now discharging to the distribution system. Regulation is still maintained as in the first position. In the third position (Fig. 6), there is a cessation of charging, and the two half batteries are shown to be discharging together in parallel. Regulation is maintained as before. In the fourth position (Fig. 7), continuous-current transformers are supplying current to the system in parallel with both halves of the batteries. The apparatus for effecting the various transpositions of the secondary batteries in the storage stations, and for maintaining the pressure constant in the mains, is automatic. The movable portions are worked by the energy which would otherwise be wasted in the counter E.M.F. cells, which are used for regulating the pressure in the distribution system. All the actuating portions of the apparatus require current at an E.M.F. of only four or five volts.

(*To be continued.*)

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *September* 28, 1889.

Since the recent introduction of the alternating-current system on a practical basis in this country, there has been a great deal of interest taken in the subject of long-distance incandescent lighting, and, as usual in this country when interest is taken in anything, the attempt has been made in a great many cases to reach conclusions. Instead of theorising on the subject, some of the companies have pushed their ideas into practice, and the result is that we have already a large number of local companies doing an incandescent service whose last lamp is several miles from the station. In fact one hears almost daily of incandescent lamps' circuits 10, 15, and 20 miles long, and if this sort of thing is kept up the arc circuits will be nowhere as compared with the incandescent for length. A good deal of this seems to be the mere straining after sensational effect and the rendering of service in which there can be very little profit, but it goes on all the same, and it is interesting as being one of the marked tendencies of the day. A very striking instance of this character has just been afforded by the Heisler plant put in at Ottawa, Illinois. Early in the present year the Illinois Valley Light and Power Company decided to put in a plant to be run by water-power, and adopted the Heisler system. The work of installing the plant had actually been begun when the company found that the necessary water-power was controlled by parties who were not favourably inclined toward the enterprise. This was rather disheartening, but instead of dropping the work, or of going to the expense of putting in a steam plant, the company immediately made up its mind to get water-power elsewhere. It thereupon sent eight miles away from Ottawa to the town of Marseilles, where it secured all the water-power that it wanted, and from that point it ran its incandescent circuits into Ottawa along the bank of the river. Some idea of the work that has been done may be formed from the fact that over 45 miles of circuits have been strung. One of these is, as stated, to Ottawa, a distance of seven or eight miles, another of 10 miles to Utica, and a third of five miles to Seneca. In each of these places incandescent lighting is being done in the houses and in the streets. For the trunk lines a No. 8 American gauge copper wire, waterproofed, is used, and the circuits also include 12 miles of No. 11. This is, I think, a rather striking example of the new class of work that is being attempted, and which, I think, we are likely to see more of in many parts of the West, if not also in numerous Eastern towns. Another illustration of this kind of long-distance work is shown by the Westinghouse plant recently installed at Englewood, Ill., one of the recently annexed suburbs of Chicago. In this place the lights operate on the familiar Westinghouse alternating system, and are from two and a-half to nearly five miles apart. One remarkable feature of this installation is that the station is an adjunct to a big planing mill. No separate steam plant is employed, the steam being obtained from the large boilers used by the mill itself, an extra boiler being held in reserve. The engine running the mill is a 400 horse-power Wheelock, and the dynamos are belted to the shaft running therefrom. The fuel costs practically nothing, being sawdust and shavings, which are shovelled in one motion from the vault into the furnace, the brick vault being placed a few feet in front of the furnace, and the sawdust and shavings being deposited therein by a system of fans and blowers, that convey it along in galvanised iron pipes from the various machines. Thus all expense for carting or handling the refuse of the mill is done away with, and the shaving has hardly been ripped from the plank before the energy that it stored up is making itself manifest in some incandescent lamp five miles away.

There has recently been quite a little discussion in the papers here as to what constitutes a secondary battery, two of the prominent parties to the discussion being Mr. E. R. Knowles, of the Mutual Company, in Brooklyn, whose storage-battery system I have given some details of lately (*Electrician*, August 2, p. 329), and Mr. G. B. Prescott, jun., the electrician of the Electrical Accumulator Company manufacturing the Faure battery. This discussion is not so theoretical as it might seem, because it involves the scope of the recent decision of Judge Coxe, whose dictum, which was quoted approvingly by Mr. Preece, was that "a secondary battery is one which gives no current of itself, but is active only when so rendered by current from an independent source." Mr. Knowles has contended that there are a large number of primary batteries which can be practically constituted storage batteries by the action upon them of an independent source in the same way as a secondary. Mr. Prescott rejoins that one of the distinguishing characteristics between true secondary batteries and primary batteries capable of partial re generation is, that whereas the electrodes of a secondary after a complete discharge remain precisely the same in weight as they were when new, the electrodes of a primary lose and gain weight, the positive being entirely consumed while the negative generally increases in weight. Another point at issue, and quite a material one, is with regard to the manufacture of plates from active material in the form of dry powder. Mr. Prescott states that he has made numerous endeavours to construct a dry powder battery, but has met with only a degree of success, not approaching the perfection attained by the Faure process. Mr. Knowles claims that he has made plates filled with dry powder

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compressed by a hundred tons pressure, which are very superior, and which, while being very dense and hard, are still so porous that if held in a horizontal position and moistened on the upper side the moisture will readily penetrate the whole mass and fall from the other side in drops. In other words, the pressure, while increasing their coherency, has in no wise injured their porosity, and Mr. Knowles believes that the limit of density has not yet been reached in practical work. The bearing of all this is apparently upon the contention of the Julien Company that they make their plates out of dry powder, and are pretty well satisfied with the results they obtain.

A new electric motor has lately been brought forward by Mr. W. Baxter, who was for some time connected with the Baxter Motor Company, of Baltimore. This motor is of the multipolar type, having its poles all on one face, so to speak, circularly arranged; and another feature is that it has three brushes on the commutator, all of which are placed on the upper side. The regulation is effected by moving the third brush automatically by the governor, and the movement of this brush maintains the speed constant by the varying the counter E.M.F. of the armature. The governor is of decidedly novel construction, rendering it possible to obtain a very good centrifugal force and governing power in small and compact shape. There is no fixed connection between the governor and the regulating brush; nevertheless, the latter is moved automatically by the governor, its centrifugal force being resisted by the tension of two springs provided with means of adjustment, whereby the normal speed of the motor may be controlled at will. These springs, as well as the arrangement by which the governor controls the movement of the regulating brush, are located partly inside the commutator and partly back of it. One of the features of this motor is also that it will reverse the direction of its torque if the speed is increased very slightly above the normal velocity, and with a still further increase the negative torque will rise very quickly. The effect of this upon the regulator is to prevent racing. This property of the machine renders it desirable in running spur-geared elevators, the motor being enabled to hold back with a force nearly as great as its maximum capacity. When the elevator is descending with a full load, it requires about two-thirds as much effort to hold it back as it does to raise the same load, and therefore, unless the descent is resisted by a force nearly equal to this, the velocity of the car would become dangerously great, while the velocity of the armature would run so high as to burst it asunder. Mr. Baxter states that the 10 horse-power motor weighs only 800lb., and runs at the low velocity of 600 revolutions per minute. He also states that he proposes to apply a modification of the same to street railway work, and that he intends to put the motor right into the car wheel, of which it thus becomes an integral part, driving directly on the car axle. This idea, I believe, is not new, but has been worked before, among the experimenters being Mr. Stephen D. Field; but, of course, if an improvement of this kind can be had it is worth securing, and Mr. Baxter's efforts will be watched with interest.

There has been a lively agitation in the gas and electric light fixture industry in this country. Some time last June an organisation was formed in Philadelphia, which has become known by the name of the Gas and Electric Light Fixture Trust, the object of this Trust being to secure co-operation between the manufacturers and the local dealers, so that prices, instead of being cut, might be held up and advanced. Among those who joined it were all the leading fixture concerns connected with electrical work. It has not been all plain sailing, however, for the new combination, as there has been a good deal of dissension in various places, notably at Louisville (Kentucky), and at Philadelphia. One leading manufacturer refused to enter the pool, and it is said that there are already disputes among some of those who are interested.

Pending the decision by the Courts with regard to the incandescent lamp patent suits now pending, Mr. Frank L. Pope, the well-known electrical expert, has occupied himself with compiling a book which he calls "The Evolution of the Incandescent Lamp." This book has been published this week, and has already excited a great deal of interest and attention. Mr. Pope's connection with the Westinghouse Company, which controls the Sawyer-Man, Maxim, and other incandescent lamp patents, is well known, and, as might be expected, the book is chiefly an exposition of the Sawyer-Man side of the case. It is, in fact, practically a synopsis or *résumé* of the evidence that has been presented on the Sawyer-Man side before the Courts, and, as far as can be ascertained, brings up no new matter. As may be supposed, Mr. Edison does not fare any too well at the hands of his doughty opponent. Perhaps when he comes home to meet this attack, after his wonderful reception abroad, he may be inclined to look upon it as the *aliquid amaris* in his cup of happiness at the present time. Mr. Pope takes the ground that the production of any invention is not exactly a spontaneous outburst or creation of an individual mind, but belongs rather to the slow evolution of a long course of discoveries and inventions at the hands of numerous workers. There is something in this theory, and perhaps it will as well suit the invention of the incandescent lamp as any other case.

BRUSSELS NOTES.

(FROM OUR CORRESPONDENT.)

BRUSSELS, *October* 1, 1889.

The tenders for the electric lighting of Brussels, which were sent in on the 1st July, are still under consideration by the Special Committee appointed for this purpose. Amongst the "*soumissionnaires*" is M. Van Rysselberghe, who has presented a somewhat novel project, which has induced the Committee to suspend its investigations into the other schemes until it has been furnished with further details of M. Van Rysselberghe's proposals.

M. Van Rysselberghe, strange to say, is no believer in central stations, but is of opinion that each consumer would prefer to produce his own light, if only the machines for driving the dynamos could be made compact, inexpensive and noiseless, and so as to require no attention. He, therefore, proposes a high-pressure hydraulic service throughout the town; the users of power would then have a suitable agent, and those who wish to have the electric light would have the means of driving their dynamos. As to the street lighting M. Van Rysselberghe proposes small central stations, the dynamos being driven, of course, by water-power. The necessary water would be obtained from the Senne, and M. Van Rysselberghe thinks that the constant cleansing of the city sewers by the used water ought alone to ensure the adoption of his plan, apart from any consideration of its superior economy.

VIENNA NOTES.

(FROM OUR OWN CORRESPONDENT.)

VIENNA, *September* 21, 1889.

Further interesting experiments have been made on the Vienna-Prague trunk line, and all ended very successfully. Speaking over single subscribers' line, Prague to Exchange, Prague Post Office, thence to Vienna Post Office, Vienna Exchange with metallic circuit underground cable to subscribers' station with the same, translators in Prague alone, the result was loud speaking and good articulation, with little noise on the line. With the same circuit, but with translators in Prague and Vienna, the result was loud speaking, good articulation, and still less noise on the line. Another experiment was carried out on the following circuit:—In Prague a subscribers' line 16½ kilometres long, single to Prague Exchange, single line to Post Office, translator then with metallic circuit line to Vienna Post Office, translator there, thence aerial metallic circuit to Vienna Exchange, thence 3 kilometres of cable, one strand earthed, the other continued overhead for 2 kilometres, single line to subscriber. In this case clear and good speaking, with a little noise, was obtained.

Many other experiments were made, all of which were successful, and, on the whole, speaking with two translators was preferable to one in Prague and connection of Vienna metallic circuit cable lines to subscriber without translator. The Landrath translator was used in both cases.

On the 18th instant the line was opened to the public from the call room in Prague Post Office to the Vienna public call room, all these belonging to the State. On October 1st the Exchange subscribers in Prague and Vienna will also be connected. The charges levied by the Government are:—One florin for three minutes' conversation (the call not counted); three florins for express connection, having precedence of the one florin connection.

As regards the Vienna-Budapest line, three metallic circuits are now being run. It is hoped that these lines will be completed by the beginning of October. The charges are to be the same as between Prague and Vienna.

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The International Electrical Company have recently sent out circulars in which they announce their intention of erecting on the shore of the Danube, in the neighbourhood of Vienna, a large central station for the supply to consumers throughout the city. The station will contain plant of a 100,000-lamp capacity, but at first plant for 20,000 lamps only is to be installed. The alternate-current system will be adopted.

The firm of Ganz and Co. are now engaged in erecting a local installation at a tobacco factory in Budapest. The current is supplied by a direct-current dynamo, supplemented by a battery of 56 Farbacky-Schöneck storage cells. The total number of lamps is 320, partly of 10 and partly of 16 candle-power.

SCANDINAVIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

COPENHAGEN, *September* 30, 1889.

A number of comparatively small towns in Sweden have already introduced the electric light, and the town of Laholm is now about to follow their example. The circumstances appear to be exceptionally favourable, a large waterfall being available about 300 yards away, and the necessary sites are obtainable on most reasonable terms.

Lighting of railway carriages by electricity has for about a year been introduced on a small portion of the new Swedish West Coast Railway. The result has been very satisfactory, and this mode of lighting the trains is likely to be adopted on other lines in Sweden. It has now been installed in all the express trains between Helsingborg and Gothenburg, and the latter town and Christiania; also in Finland the electric light has been introduced in the sleeping cars between Helsingfors and St. Petersburg, and in Denmark at least some of the trains between Copenhagen and Korsör are lighted in the same manner.

Some interesting statistics have just been published about the telephone in the service of the Swedish State Telegraphs, which institution employs the former mode of communication to a considerable extent. During the year 1888 the Swedish State Telegraphs laid 1,724 kilometres of telephone lines, the cost amounting to 277,711kr. (kroner=one shilling), to which must be added the money paid for the Gothenburg Telephone Company, viz., 172,640kr., making a total outlay on the part of the State Telegraphs on telephones during last year of 450,352kr. At the close of last year the State Telegraphs possessed altogether 7,218 kilometres of telephone lines, with 3,389 telephones. There were 54 central stations, and 74 telegraph stations had telephonic connection. The number of telegrams and communications despatched at the State Telegraphs through the medium of telephones was as follows:—

Telegrams received through telephone for further despatch	30,967
Telegrams further despatched per telephone	29,306
	60,273
Telephonic communications.....	7,924
Telephonic conversations, at 50 öre (6½d.).....	25,778
Telephonic communications between subscribers	5,146,654

Of private telephone lines (including, of course, those of the various telephone companies) there was a total of 30,676 kilometres, with 302 central stations and 14,234 telephones.

The Corporation of Copenhagen have now decided that they will themselves erect one or two central stations in Copenhagen for electric light. There are two localities where the conditions are very favourable for such stations, better by far than what any town in Germany can boast of. The calculated cost for the first station to be taken in hand is 1,400,000kr., of which 450,000kr. will be absorbed for site and alterations. The number of lamps will be 10,000 incandescent lamps (might be extended to 14,000), and the area will not be beyond a distance of 2,000ft. from the central station. The projected station is intended for indoor lighting, but it is not improbable that the plan may be considerably modified before being realised. It has been argued that the station might with a comparatively small additional cost be increased to a capacity of 20,000 lamps, which would enable the Corporation to use the electric light for the lighting of the large and handsome square, in the immediate proximity of which the first central stations will be located. Voices have also been raised against the Corporation working the electric light themselves, and a fear expressed that they will overcharge and take undue advantage of their monopoly, as many accuse them of doing with their gas works. The calculated annual expenses on the above projected central station are 194,100kr., whereas the gross profits have been put at 274,000kr.

In Stockholm the question of electric lighting seems also to be progressing, and there, too, the gas works seem inclined to take up the matter of electric lighting. The Stockholm Gas Works have been working an experimental station, as it is called, which has given most satisfactory results, and proved the good qualities of the system adopted during last year. There were altogether fixed in Stockholm, by the various electric companies and private electric engineers, 3,832 incandescent and 103 arc lamps, which brought the aggregate at the end of 1888 up to 14,372 incandescent and 247 arc lamps. The electric lamps are 10 per cent. of the number of gas flames, but the consumption of gas has notwithstanding increased with more than 6 per cent. during the year—an experience which tallies with that mode in several other European capitals and large towns.

The Landscrona sugar manufactory, Sweden, has contracted with Mr. Davy Robertson, of Gothenburg, for an electric installation, consisting of eight arc lamps and 220 incandescent lamps.

The town of Holmstad, in Sweden, has also just contracted for a good-sized electric installation with the well-known Stockholm firm of J. E. Eriksson, representatives for Siemens and Halske. The installation comprises a minimum of 1,000 incandescent lamps, and upwards of 80 arc lamps, and has to be completed by July 1st, next year.

CORRESPONDENCE.

THE B. A. COMMITTEE "ON THE MAGNETISATION OF IRON."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just read a paragraph in your issue of September 27th, in which you comment on the report of the Committee on the "Magnetisation of Iron," read in Section A of the British Association. Permit me to say that the Committee referred to is one for the investigation of certain "Molecular Phenomena associated with the Magnetisation of Iron, Nickel, and Cobalt," and that, as stated at Newcastle, the report of the Committee is deferred till next year, the note presented being merely a brief summary of some of the remarkable phenomena which cluster round the critical temperature at which recalescence occurs in iron and steel.—I am, Sir, &c.,

THE SECRETARY TO THE COMMITTEE.

THE DEFINITION OF IMPEDANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Glazebrook has done a service in pointing out that what is meant by impedance only in particular cases takes the form $\sqrt{\{R^2 + L^2n^2\}}$. This will serve to explain why I have not called this function the impedance, for which you find fault with me in your number for June 21st last. This expression would not represent the impedance, for instance, if there is any mutual induction to be considered.

Of course, it is by a printer's error [No.—ED. *E.*] that the integrals in Mr. Glazebrook's formulation do not appear under the sign of the square root, and I presume it is by a slip of the pen that in the definition the *effective* (and not the impressed) electromotive force is spoken of. Unfortunately this involves the whole question of the expediency of the term.

As long as men dealt merely with steady currents they got on very well with the simple law $\frac{E}{R} = C$, but directly a variable current was employed they found that generally a smaller current was obtained than that represented by the ratio $\frac{E}{R}$. To obtain this when E and R are both known, it will be necessary either to increase R or to diminish E. If the former alternative is adopted the increased R is called impedance. If the latter alternative is adopted, the diminished E is called the effective electromotive force. Why, in the former case, the impedance should not be called effective resistance, not being a member of any Congress, I cannot say. There is just as good reason for giving a single name to the effective electromotive force; from some points of view even better reason. I hasten to air the suggestion, in order that it may *not* be adopted. But I think there is another ground for not using the word impedance. Suppose the conductor to be connected at two points with the plates of a condenser. The current will then be different in the two sections of the conductor. Which are we to choose for the denominator in the formula defining the impedance?

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In a subaqueous or subterranean cable again the current[2] varies from point to point, and the difficulty is increased indefinitely.—Yours, &c., THOMAS H. BLAKESLEY.

Royal Naval College, Greenwich, Oct. 5, 1889.

[Although our correspondent is, of course, quite right in saying that the integrals should come under the radical sign in the formula in question (see *The Electrician*, Sept. 27th, p. 516), yet the printers are not to blame in the matter. We have commented on Mr. Blakesley's objections to the term impedance in another column.—ED. *E.*]

PROFESSOR ELIHU THOMSON'S EXHIBIT AT THE PARIS EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your description of my exhibit at the Paris Exposition, which appeared in your issue of September 13th, 1889, you refer to the existence of a voltmeter constructed on the electrostatic principle, and close the paragraph by the statement "The instrument closely resembles the electrostatic voltmeter designed by Sir William Thomson." I would say in relation to this that the instrument is nothing more or less than an electrostatic voltmeter, the design of which is due to Sir William Thomson. There is nothing else claimed for it, but in my exhibit it was to be taken in connection with auxiliary apparatus accompanying it, of which your correspondent had evidently not taken notice. The electrostatic voltmeter in question is to be used with a miniature transformer whose primary, of comparatively coarse wire, can be attached to low-potential alternating mains, such as 50-volts secondary mains, the secondary of which transformer is wound with very fine and carefully insulated wire and magnifies the potential 100 times, making it 5,000 volts. The fine wire secondary circuit is then connected to the electrostatic voltmeter of the Sir William Thomson pattern.

The object was to show the possibility of reading low potentials by an electrostatic voltmeter.

For continuous currents the same voltmeter is to be used with a set of condensers charged in multiple at a low voltage, say 100 or thereabouts, and discharged in series by a revolving connection cylinder, so that the potential may likewise be magnified before it is applied to the voltmeter. These two auxiliary devices, the miniature transformer and the set of condensers, were both shown in the exhibit, and ought to be found there in connection with the voltmeter in question.

It may be of interest to your readers to know that the alternating-current motor sketched in Fig. 8 of your article has a single field circuit, and that the armature may be started in either direction, and will increase its speed to nearly synchronising speed if run without load. The machine may then have the load thrown on. An increase of its load tends to diminish the speed somewhat from approximate synchronism. An overload stops the motor. The principle of operation of this motor, I think, is novel. Its action depends on the combined effects of lag of induced current and displaced relation of waves due to translation or rotation of the armature, the initial direction of rotation being that which determines the direction of displacement of waves during their formation, with the effect of setting up a repulsion to the closed armature coil from the field coil which it is leaving, and an attraction for that coil which it is approaching. In other words, the rotatory effort is an effect of magnetic distortion brought about by the combined action of lag of the induced current in the armature coils and the movement of rotation which has been given to the armature initially, and which determines the direction of continuance of such motion.—Yours, &c., ELIHU THOMSON.

Lynn, Massachusetts, Sept. 25, 1889.

THE DEPTFORD CENTRAL STATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It will probably be of interest to your readers to know that during last week current was transmitted from our Grosvenor Station to the Deptford Station with satisfactory results. This transmission of current was made as part of the preliminary work to starting our Deptford Station, from which we shall be supplying current in the course of a few days, a slight delay having been occasioned by the strike at Silvertown, and the consequent non-delivery of a few small parts required for the completion of our machinery.

We are supplied here with electric current from the Grosvenor Station, the E.M.F. of 2,400 volts, at which the current is supplied, being reduced by transformation to 100 volts in the ordinary manner. This current of 100 volts was put into a transformer at our temporary distributing station here, and raised to 2,400 volts, and again into other transformers, raising the E.M.F. to 5,000 volts, at which tension the current was passed through our cables direct to our Deptford Station. There the E.M.F. was successively reduced by transformation to 2,400 volts and to 100 volts, and at this latter working tension our works at Deptford were illuminated.

Doubts have been expressed in many quarters whether we should succeed in transmitting current so great a distance as that between London and Deptford; well, those doubts are now finally dispelled, and the confidence felt by the exponents of the transformer system is fully justified It is also now demonstrated that current can be transmitted without loss of E.M.F., for, notwithstanding five transformations, the E.M.F. of the working tension at Deptford was the same as at these premises.

It may be asked why so many transformations were made. The answer is that we have our transformers constructed for successive reductions from 10,000 volts to 2,400, and finally to 100 volts, and starting, as we were obliged to do, with an E.M.F. of 100 volts, we had to raise and lower the tension in the manner described. I should explain that our system admits of our obtaining a 5,000 or 10,000 volt tension at pleasure by the manner in which we couple our transformers, and that for the purposes of this trial a tension of 5,000 volts was sufficient.—Yours, &c., CHARLES B. WALLER,

Manager and Secretary London Electric Supply Corporation (Limited).

3, Adelphi-terrace, W.C., 9th October, 1889.

[It is scarcely necessary to observe that the proof which our correspondent offers in support of his thesis that "current can be transmitted without loss of E.M.F." would equally well serve to show that "current can be transmitted with an actual gain amounting to thousands of volts." It would merely have been necessary to stop at an earlier stage in the demonstration.—ED. *E.*]

THE STRIKE AT SILVERTOWN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As misleading statements are being circulated with reference to a strike at our Silvertown factory, we ask you to give publicity to the particulars of weekly wages paid by us up to 14th September last, which will be found to compare favourably with those paid for similar work in any part of England:—

	Hours.	Pay.
Labourers (including yardmen and stokers)	63 ...	26s. 3d.
India-rubber departments.....	63½ ...	33s. 7d.
Cable, wire-covering, battery, gutta-percha, electric light, and general departments.....	60 ...	28s. 1d.

No able-bodied labourer employed by us received less than 4¾d. an hour. The above payments do not include those made to foremen, clerks, and skilled mechanics of various classes, who, of course, draw much higher wages.

We employ a considerable number of women and boys, who are not included in the above statement, but who are paid on a scale proportionate to that of the men.

The workpeople are practically in permanent employment, their weekly number not varying much during the year; and our workshops are large and well ventilated and lighted, and our appliances of the best.

Our factory is in the neighbourhood of the docks, and the recent strike there appears to have unsettled the minds of some of the workpeople. The majority of them, however, have been intimidated into leaving their work, having, when going to their meals, to pass through a crowd who hissed and groaned at

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them and used violent language. In some cases they have been hurt, but will not give evidence lest worse should befall them.

Yesterday about 115 women, who were satisfied with their pay, left work under intimidation, and there are now about 1,600 workpeople thrown out of employment, leaving only 250 still at work.—Yours, &c. WM. J. TYLER, Secretary.

Oct. 4, 1889.

THE HIGGINS' COLUMN PRINTING TELEGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent, Mr. W. M. Monroe, who in last week's number claims priority of invention for a Column Printing Machine by a Mr. Irish, of which a description was published in 1883, is mistaken in supposing that it was five years earlier than the invention of my Column Printing telegraphic apparatus.

My first patent for a Column Printing Telegraph was granted in the year 1880, and my last patent in the year 1887.

My Column Printing apparatus, which is at present in use at the West-end of London, was constructed, and a description published, before the date of Messrs. Wright and Moore's application for a patent.—Yours, &c., F. HIGGINS.

17 and 18, Cornhill, E.C., October 7, 1889.

THE TESTS OF THE BROOKS' UNDERGROUND SYSTEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The test to which I referred in my letter of last week was not intended to represent the conditions which would obtain in an electric light cable. To have made a telephone cable do duty for an electric light cable would have been manifestly absurd, and especially so in this case, as we had a cable laid eminently suitable for electric light purposes, which was tested in the presence of Mr. Ferranti's representative, and which proved to be of a very high insulation resistance.

The test on the telephone cable, with the wires all bunched together, was undertaken as a confirmatory test to the previous ones, showing that not one of the wires was faulty, and that the average insulation was good.—Yours, &c., H. C. HALL.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

September 23, 1889.

15,045. C. M. DORMAN and R. A. SMITH. Manchester. Improvements in electric switches and safety fuses for supply station distributing boards.

September 25, 1889.

15,096. J. T. RATTRAY and K. LOWDON. Dundee. Combination lampholder and switch.

September 26, 1889.

15,155. A. DICKINSON. Birmingham. Improvements in the mode of storing and renewing the secondary batteries of electric tramcars.

September 27, 1889.

15,230. Sir W. VAVASOUR. London. Improvements in electric batteries.

15,235. F. V. ANDERSEN. London. Improvements in dynamo-electric machinery.

15,242. J. GILMORE and W. R. CLARK. West Norwood. A compressed air automatic heat and electric-current regulator and indicator.

15,246. W. LAHMEYER. London. Method or means of regulating motor dynamos or continuous-current transformers.

15,248. C. H. CATHCART. London. Improvements in electrical switches.

September 28, 1889.

15,272. A. G. BURRELL. Glasgow. Improved apparatus for adapting telephone line wires for use in synchronising clocks.

15,293. A. F. ST. GEORGE and A. ST. GEORGE. Redhill. Viewing distant objects by means of electrical apparatus and conducting wires.

15,299. J. H. PRATT. London. Improvements in the electrical reduction and recovery of metals from metallic ores and from compounds and mixtures containing metals.

15,303. W. MOSELEY. London. Improvements in electric bells.

15,308. J. A. MCMULLEN. London. Improvements in driving dynamo electric machines.

15311. E. JETTE. London. Improvements relating to telephonic apparatus.

September 30, 1889.

15,319. J. M. M. MUNRO. Glasgow. An improved switch for making and breaking contact.

October 1, 1889.

15,377. C. C. PECK. London. Improvements in electric machines or motors.

15,387. E. DE PASS. London. Improvements in electrotyping (C. Juncker, France).

15,402. W. P. THOMPSON. Liverpool. Improvements in or relating to alternate-current electric distribution (G. Westinghouse, jun., United States).

15,446. S. C. C. CURRIE. London. Improvements in the method of and apparatus for "forming" or charging plates for electrical accumulators.

15,449. W. T. GROVER. London. Improvements in electrical cables.

October 2, 1889.

15,489. F. TEAGUE. London. Improvements in electricity meters.

October 3, 1889.

15,509. C. H. MARTIN. Middlesborough. Improvements in electric bells.

15,524. F. H. BERRY. London. Improvements in electric bells.

October 4, 1889.

15,567. J. KINCAIRD, E. MANVILLE, and J. E. WALLER. London. Improvements in means for propelling vehicles by electricity.

15,609. F. L. BACHMANN. London. Improved electrical railway switch and signal apparatus.

October 5, 1889.

15,643. J. A. KINGDON. London. Improvements in rheostats or apparatus for regulating electric currents.

SPECIFICATIONS PUBLISHED.

1888.

11,354. LORRAIN. Utilising electric energy, &c. (Price 8d.)

11,898. SHALLENBERGER. Indicating strength of current upon an electric circuit. (Price 8d.)

15,601. HARCOURT. Electric bells. (Price 6d.)

15,713. SALOMONS and FARADAY. Connector for electrical conducting wires.

16,212. GOURAUD (Edison) phonographs.

16,905. DYMOND (Schwenke). Electrical locks. (Price 8d.)

1889.

11,676. ALLISON (Porter). Printing order telegraph. (Price 1s. 1d.)

11,900. DALLOS. Conduit for electric railways. (Price 6d.)

12,731. KOOKOGEY. Secondary batteries. (Price 8d.)

Second Edition.—1887.

9,155. WORMS and BALÉ. Tanning by electricity. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited).

The first general meeting of the above-named Company was held at the Cannon-street Hotel, E.C., on Friday, the 4th day of October, for the purpose of transacting the ordinary business of the Company. Sir John H. Morris, K.C.S.I., Chairman of the Company, presided.

Mr. J. SHURMER, the Secretary, read the notice calling the meeting.

The CHAIRMAN said that before making any particular observations he wished to tell the shareholders that this was a meeting of the Foreign Elmore Company and not a meeting of the original Company. He wished further to call to their notice that it was only a statutory meeting and that their proceedings would therefore be of a somewhat formal nature. There would be no report to be read and no balance-sheet or accounts to submit, but at the same time he might tell them that the public subscription was more than applied for, and that the allotment was made in full, also that the calls had been regularly paid up, and that there were no substantial arrears. Application had also been made for a special settlement and quotation for their shares on the Stock Exchange, and as soon as they had made certain trivial alterations in the Articles of Association—for which a special meeting had been convened that day—they would no doubt obtain what they had asked for. So much for general particulars as to their affairs. The Company had now been in existence for some four months, and the proprietors would doubtless wish to know what had been done so far. He wished to remind them, as stated in the prospectus, that the Company was formed for the purpose of acquiring certain patent rights for foreign countries in the Elmore process, which were enumerated in the prospectus. It was also stated that it was not the intention of the Company to work those patents, but to re-sell such patents by forming subsidiary companies for different countries, and that negotiations had already been commenced for the sale of those patents. Now, the first thing done by the Directors after the formation of the Company was to again go into the different rights and certificates in the foreign countries, as stated in the prospectus, and then the next step was to consider whether they should at once proceed to form the subsidiary companies, and renew and carry on the negotiations that had already been commenced to that end, or whether they should wait for the successful completion of the Elmore processes in England and the demonstration to the general public of the capabilities of the invention. They went fully into the matter, and they found that in the case of almost every proposal and application which

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had been made to them the people required various tests and experiments to be conducted before they would be satisfied to complete their negotiations and conclude the terms. The effect of such a state of things was naturally to very greatly reduce the estimated money value of the patents if they had sold them then, and they felt, therefore, that the wise thing to do was to wait until the success of the home Company had proved the commercial value of the process to the satisfaction of the public. They felt that it was only then that they would get the full value of their patents, and they decided therefore, after full consideration, that they would not for the present at all events renew the negotiations or receive any proposals whatsoever unless they were of a more definite character. They replied to a gentleman, who wished to continue negotiations with them, as follows :—

"Sir: I am directed to acknowledge the receipt of your letter, and to say in reply thereto that until the Company is in a position to fully satisfy the public generally in regard to the commercial value of the Elmore process my Board must refrain from committing themselves to any proposals in the matter for the sale of all or any of our patents, or to enter upon any exclusive negotiations to that end. At the same time, any specific and definite offer made to this Company for the whole or any of the patent rights would have the careful consideration of the Directors."

He (the Chairman) trusted that the shareholders would approve of the action of the Directors in the matter. He need scarcely tell them that had they proceeded to reopen negotiations on the terms already mentioned they would have been offered a very much smaller amount for their patents than they had every reason to hope and believe they would receive when the patents had been proved and the processes were at work in England. As they said in the letter that he had just read, they were perfectly prepared to receive and to carefully consider any specific and definite offer that might be made to them. As the shareholders would readily understand, no definite offer whatever was made to them; the people did not want to make definite offers, but in fact, in his opinion, to enter into negotiations with them, and to get them into such a position that they would be very much prejudiced and compelled to accept terms very much lower than they would receive if they waited until the development of the works of the English Company was carried out successfully. When he said carried out successfully, he did not mean to convey that the Directors of this Company had any doubt whatever as to the ultimate success of the concern, but they had to prove this to the satisfaction of the public, and to show that the results were really being believed in England. It would be perhaps recollected by some of them that when the meeting of the original Elmore Company was held it was announced that a series of experiments were being conducted in Paris, and that these experiments were only on a very small scale. Now, in order to be entirely satisfied in the matter, and to satisfy the public, works of the home Company were in course of erection for working the process on an extensive scale, and they had every reason to believe that the results would be most successful, and would qualify them to renew negotiations and to carry them out successfully. There was one point upon which the shareholders would, of course, be anxious to have information, viz., when it was likely that they would be in a position to carry out the process to the full satisfaction of the public. Well, when this Company was first formed they had every reason to hope and believe that by the present time they would have been in the position to which he had referred, of seeing the successful completion of the Elmore processes carried out to the satisfaction of the public and all concerned. A few weeks after the formation of the Company, the erection of the buildings necessary for the plant was begun, but the work was soon stopped in consequence of a strike amongst the workmen engaged thereon. The matter in dispute, which was the cause of the strike, was a very trivial one—at least it appeared so to the board—it being only the question of an increase of one-halfpenny per hour in the salary or pay of the bricklayers' workmen. So impressed were the Directors of the Elmore Company of the absolute necessity of preventing any possible delay, and of pushing on the works to the utmost extent in their power, that they offered themselves to make up to the contractors the difference, provided they agreed to the terms that were demanded by the workmen. Unfortunately, the contractors would not agree to it, and as there was in the contract the regular strike clause the Company were unable to claim any damages from the contractors. The result was that there was a delay of from six weeks to two months, but he was now very glad to be able to inform them that some weeks since the work was recommenced and was now going on most satisfactorily, and they had every reason to hope that in the course of a few weeks the buildings would be erected and the whole of the Elmore processes completed and carried out to the full satisfaction of the public, and they would have demonstrated to them the great commercial value of their process. Of course, as soon as this was done the Directors would be in a position to renew negotiations for the forming of subsidiary companies, and the value of the patents having thus been fully demonstrated, they would be able to obtain considerably enhanced terms to what would have been the case before. Continuing, he said that there was only one other point to which he had to refer, which was that they had received applications or proposals from some eight or nine different parties for the renewal of negotiations for different foreign countries, namely, France, Belgium, Italy, Switzerland, Spain, Germany, Canada, United States and Sweden. He had little doubt that as soon as the results of the home Company were known they would receive many more applications than those that they had already received. He believed that that was all he had to say, but if there was any particular point that he had omitted to refer to, or any question that any gentleman would like to ask, he or one of his colleagues would be glad to answer it, and to give the best information in their power. He had, as he had said, no resolution to propose.

No questions being asked by any shareholder,

The CHAIRMAN said that it appeared they were all satisfied with his statement, and they would therefore consider the business for the statutory meeting as over, and they would now proceed to the work that they had to transact at the special meeting. Accordingly an extraordinary general meeting of the shareholders was then held in order that the subjoined resolution—rendered necessary in order to comply with the requirements of the Stock Exchange before that body would give the Company a special settlement and official quotation of its shares—might be proposed, namely :—

That the following Clauses of the Articles of Association of this Company be and the same are hereby altered, revised, added to, repealed and (or) cancelled, as follows :—

"*By striking out of the second paragraph of Article 24 the words, 'on any bill or note or contract remaining unperformed.'*

"*By striking out of the second line of Article 60 the words 'one-fifth,' and substituting therefor the words 'one-tenth.'*

"*By striking out of Article 71 the words 'hereafter to be elected.'*

"*By striking out entirely Article 82.*

"*By adding to Article 105, after the words 'such securities as they may select,' the following words, 'subject always to Article 36.'*"

Mr. J. SHURMER, the Secretary, read the notice.

The SOLICITOR of the Company, Mr. Hays (Newman, Hays and Co.), explained the object of the alterations, and read the amended articles.

The CHAIRMAN then proposed the resolutions *seriatim*.

Mr. HOLLAND seconded them, and they were all carried.

The SOLICITOR said, that to be perfectly legal they must also be carried *en bloc*.

The CHAIRMAN moved the approval of them *en bloc*.

Mr. HOLLAND seconded.

The motion was carried.

The CHAIRMAN said that it would be needful to hold another meeting to confirm the resolutions that had been passed, so as to render them

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS; BAGOT STREET, BIRMINGHAM.

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special resolutions; the shareholders would receive a notice in a few days time, and the meeting would, being a purely formal matter, take place at the Company's offices in Bucklersbury.

A vote of thanks to the Chairman closed the meeting.

Anglo-American Brush Electric Light Corporation, Limited (in voluntary liquidation).

A meeting of the shareholders in this Corporation was held at the offices, 112, Belvedere-road, on Thursday, "to settle the list of contributories." Mr. E. Garcke, one of the liquidators, presided.

The CHAIRMAN said: I have to thank you, gentlemen, for attending the meeting, but the business is purely formal. It is simply to settle the list of shareholders who are contributories, and to enable us to prepare and issue the new certificates of the new Company—the Brush Electrical Engineering Company (Limited). I may take this opportunity of stating that the business of the new Company is proceeding very satisfactorily. We are exceedingly busy with current orders, and the arrangements have been completed for taking over the new works at Loughborough of the Falcon Company. We are very busy there. I may say that those works are fully occupied at present with orders from the new Company, so that they are almost independent of their old customers. I shall be happy to answer any question that any shareholder may put to me, but unless any objections are raised by any shareholders, the list which I have prepared will be settled, and the new certificates will be made out by the new Company in accordance with this list. The shareholders have all had notice of their holdings as settled in this list. The meeting has been called in accordance with the Companies Acts, so as to give shareholders an opportunity of objecting if they see fit.

Mr. WM. ASH said he had been connected with five or six other electric light companies, some of which had disappeared entirely, involving him in considerable loss. He hoped that this Company would be an exception in that respect. What was meant by par value?

The CHAIRMAN: That means the nominal value of the shares. The nomiual value of the Old Shares is £5, and of the New £2 for the Preference and £3 for the Ordinary Shares. You will receive one Preference Share of £2 and one Ordinary Share of £3 in the New Company in exchange for one Old Share of £5. As there are no other questions I may take this list to be settled.

The proceedings then terminated.

NEW COMPANIES REGISTERED.

THE ECONOMIC GOLD EXTRACTION COMPANY (LIMITED).—Registered by Slade and Munk, St. Clement's House, Clement's-lane, E.C., with a capital of £175,000 in £1 shares. Object, to adopt an agreement, dated May 6, made between C. E. Mildenhall and H. M. Collins as trustee for the company; to acquire the patent rights and property referred to in such agreement, and to continue the business therein mentioned; to enter into agreements or contracts to purchase, deal in and with mineral, chemical, and electrical properties and inventions of every kind on such conditions as the directors may deem expedient. There shall not be less than three nor more than seven directors, the first to be appointed by the subscribers to the memorandum of association. Qualification, £100; remuneration, £1,300 divisible, and 5 per cent. out of net profits after 10 per cent. dividend.

THE MAQUAY SYNDICATE (LIMITED).—Registered by Johnson, Budd and Johnson, 24, Austinfriars, E.C., with a capital of £12,000 in £100 shares. Object, to acquire or enter into arrangements for the option of purchasing the benefit of the inventions for an improved voltaic battery for improved means for feeding electric batteries and for removing the plates therefrom, and for a miner's lamp, respectively protected by letters patent, No. 15,040 of 1885, No. 990 of 1887, and No. 14,932 of 1888.

NEW SPANISH ELECTRICAL COMPANY.—The *Dia* of October 5 announces the formation of a new company in Bilbao under the title of "La Electra," with the object of supplying the electric light to the public. The chairman of the company is D. Manuel de Ayarragaray, vice-chairman D. Ramon Bergé, and the other members of the Board Signors Eduardo de Achutegui, Luiz de Zubiria, and Jose A. de Ibarra. The managing director is D. Valentin de Gorbéna.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The accounts of this company, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 1s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended 30th June, 1889, and also the payment of a bonus of 3s. per share, both free of income tax, which together will amount to £26,000, being a distribution in the aggregate of 7½ per cent. for the past year, leaving a balance of £47,609. 3s. 9d., of which amount £45,000 has been placed to the reserve fund, increasing that fund to £259,660. 9s. 8d., and £2,609. 3s. 9d. carried forward. The above dividend and bonus will be payable on the 7th November next. The receipts of this company for the week ended October 4, 1889, amounted to £2,936.

DIRECT SPANISH TELEGRAPH COMPANY.—The traffic receipts of this Company for the month of September, 1889, amounted to £2,139, as compared with £1,888 last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—This company announce the payment by warrants on the 1st of November next of interest for the half-year ended October 31st on their Four per Cent. Mortgage Debenture Stock. The books will be closed from the 27th October to 1st November both days inclusive. The traffic receipts of this company for the month of September, 1889, amounted to £51,881, and to £49,273 in the corresponding period of 1888.

GLOBE TELEGRAPH COMPANY.—This company has declared an interim dividend of 3s. per share on the Preference Shares, less income-tax, and of 2s. per share on the Ordinary Shares, income-tax having already been deducted.

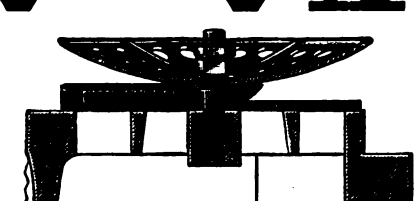
GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company for the month of September, 1889, amounted to £25,000. From the 1st January to 30th September, 1889, they were £203,200, against, in the corresponding months of 1888 and 1887, £202,600 and £197,720 respectively.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 4, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £1,604.

THE ELECTRICITY SUPPLY COMPANY FOR SPAIN (LIMITED).—Subscriptions were invited this week for a capital of £100,000, in 19,900 Ordinary shares of £5 each and 100 Founders' Shares of £5 each in the above undertaking. The directors of the company are the Right Hon. Lord Castletown of Upper Ossory, chairman, Sir Henry Cartwright, Knt., 1, Courtfield-gardens, South Kensington, S.W., Robert A. Germaine, Esq., M.A., L.C.C., 21, Philbeach-gardens, South Kensington, S.W., Alfred G. Gillingham, Esq., George-road, Sutton, Surrey. The managing director is Exmo. Señor Don Pedro Pastor y Landero, Madrid. The engineer is F. C. Phillips, Esq., Assoc.M.Inst.C.E., M.Inst.E.E., and the secretary *(pro tem.)* is Philip Arderne Latham, Esq. The company is (the prospectus states) formed for the purpose of erecting a central electricity supply station in Madrid, under a concession recently obtained from the authorities there, for the purpose of generating electricity on a large and economical scale, and distributing it by means of underground mains to premises requiring electric lighting or motive power. The concession is unlimited in duration. The company does not intend to confine its attention to Madrid, but contemplates extending its operations to other important towns in Spain. The company is bound to no particular system, and in the prosecution of its business will be free to adopt the best means available from time to time for the generation and distribution of the electric current. Messrs. Hammond and Co. have contracted to erect a central station in Madrid for the company. It may be worth mentioning that the price of gas in Madrid is over 9s. per 1,000 cubic feet. The offices of the company are situate at 15, St. Helen's-place, E.C., and at 13, Goya, Madrid. The list of applications for shares closed yesterday at 4 p.m.

NEW VALVE

No Rubber, Percha, or Leather.



One-half the price of Rubber or Metal.

FOR CIRCULATING AND AIR PUMPS.

Unaffected by any Lubricating Oils. Does not Expand in diameter. Feed Water may be worked at any temperature Suitable for any shaped guards. Only one quality manufactured.

"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to MOSSES & MITCHELL, 68-71, Chiswell Street, London.

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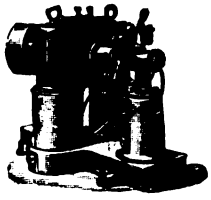
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Oct. 9, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 9, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	15/0	Anglo-American	53 54	4 12 7	Jan., Apr., July, Oct.	53½	...
2,614,820	Stock	30/0	Do. Preferred	89½ 90½	5 10 6	,, ,,	90⅜	89⅞
2,614,820	Stock	...	Do. Deferred	17⅜ 18⅛	...	February	18	17⅛
130,000	£10	5/0	Brazilian Submarine	13½ 14	5 14 4	Mar., June, Oct., Dec.	13⅞	13¼
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	14⅞	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	20⅛	20
12,931	5	1/7½	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10⅝	5 16 2	Jan., Apr., July, Oct.	10⅝	10⅜
380,000	10	5/6	Eastern	13⅞ 14⅛	4 12 0	,, ,,	14	13⅞
70,000	10	6%	Do. 6 per Cent. Preference	15½ 15⅝	3 16 2	,, ,,	15⅝	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	...	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 13 10	Jan., Apr., July, Oct.	14	13⅝
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	102½	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	105½	103½
179,177	10	4/0	Globe Telegraph and Trust	8¾ 9	5 2 9	Jan., Apr., July, Oct.	8⅛	8⅝
178,992	10	3/0	Do. 6 per Cent. Preference	14⅞ 15⅛	3 19 4	,, ,,	15	14⅝
150,000	10	5/0	Great Northern	15 15⅛	4 15 9	Jan., July, and April	15⅝	15⅛
17,000	25	37/6	Indo-European	42 44	5 13 8	April and October	...	...
9,000	8	8/0	Reuter's	6¾ 7¼	5 10 2	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
80,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	10⅛	10⅞
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	126½	...
88,321	10	nil.	West India and Panama	2¼ 2½	...	...	2⅜	2¼
34,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12⅛	...
4,669	10	*	Do. 6 per Cent. 2nd Preference	14½ 15¼	...	...	...	...
45,181	15	9/0	Western Brazilian	9¾ 10¼	7 10 5	March & September	10⅜	10
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	1⅛ 1⅜	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 4	...	...	...
55,000	5	...	United River Plate	5 5⅛	...	January and July	5⅛	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	4 4¼	...	...	...	...
23,692	5	2/0	Do. (fully paid)	5 5¼	...	February & August	5⅜	5¼
79,934	5	...	Swan United (£3. 10s. paid)	5¼ 6	...	...	5⅞	5⅛
500,000	10	...	Metropolitan Electric (£3 paid)	3¾ 4¼	...	...	...	...
			MISCELLANEOUS.					
87,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 5	March and July	46	45¼
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	19 20	5 0 0	February & August	19½	...

* No dividend since May, 1880.



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ELECTRICAL PLANT & ACCESSORIES

WRITE FOR THE FOLLOWING PAMPHLETS TO THE

UNITED ELECTRICAL ENGINEERING CO., Ltd.

Head Offices: 3, Princes Mansions, VICTORIA ST., WESTMINSTER.

"ELECTRICAL DISTRIBUTION."—Commercially considered, with Estimates.

"MACHINE DRIVING BY ELECTRICITY."—The Uses of Electro-Motors for Traction and Stationary Purposes.

"THE TELPHER SYSTEM OF CHEAP TRANSPORT," for Minerals, Goods and Passengers.

"ELECTRICAL SUPPLIES."—Prices and Particulars of the most approved Electrical Appliances.

ELECTRICAL PLANT ON VIEW.

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

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NOTES.

A Reuter's telegram from New York announces that in the action brought by the Westinghouse Company to restrain the Edison Lamp Company from infringing the Sawyer-Mann patents, judgment has been delivered in favour of Edison. The case seems to have turned not on the flashing process, but on the Sawyer-Mann claim for the use of a "fibrous or textile substance" for incandescent lamp filaments. We shall no doubt receive full particulars from our New York correspondent within a few days.

We reprint from the New York *Electrical World* an able article by Dr. Louis Bell "On the Present State of Traction by Storage Batteries." This is a question which affects us even more closely than it does our American cousins, seeing that perhaps as much as 75 per cent. of our tram lines cannot be worked electrically by any other method at present in the field. It is well that this fact should be fully recognised. Such systems as the "Series" and the "Lineff" are well adapted in themselves for suburban traffic, and either of them would probably add perceptibly to the dividends of many such lines. But, unhappily, even here a vested interest of the most powerful and ubiquitous character challenges their intrusion. We refer to the cyclists, and it is impossible not to sympathise with their aversion to the "slot."

Returning to Dr. Bell's Paper, we find that he estimates the efficiency of battery traction from the indicated horse-power of the engine to the power delivered on the wheel axle at 40 per cent. We do not think that this can be considered an unfair estimate. For direct working with overhead lines Dr. Bell allows no more than 50 per cent. efficiency. There is, however, another point to be considered before direct comparison can be made—How much of the work done by the batteries is uselessly expended in dragging their own weight? To make the comparison quite fair Dr. Bell takes the "economic coefficient" of each system, which is obtained by multiplying the commercial efficiency by the ratio useful weight/total weight of the car and its equipment. This gives the value 38·5 per cent. for the direct system, and only 18 per cent. for the batteries. What we need (we wish there were some better prospect of getting it) is a far lighter cell, and one capable of withstanding the disintegrating effects of continuous changes of current density. In this direction progress has been very, very slow. Recently we hear hopeful accounts of a cell which is, we believe, now being tried in actual work by the Electric Traction Company. This company has had a long and somewhat trying experience, and may certainly be trusted to know what is wanted in a traction cell.

In view of such considerations as these, we really have very little patience with the persons whose "system" consists in having two motors on each car, to be used one at a time, or in putting the cells in a separate trolley. There *may* be, probably there is, something to be said for the latter suggestion, but in the former, regarded as an "invention" and a "system," we have never been able to perceive the merit. If we can only get a really efficient battery, we need not worry much about the motors.

We have received a card of invitation from the Executive Committee of the Magnetic and Hypnotic Society of Great Britain to be present at an experimental lecture by *Professor* Milo de Meyer on "Practical Magnetism and Hypnotism." So far as we can judge from the list of Council, this Society appears to be fathered by men of good standing. We must, however, emphatically protest against the use, or rather misuse, of the word magnetism. Nothing in the nature of scientific proof has up to the present been brought forward establishing a connection between magnetism and physiological phenomena. Meanwhile, the employment of the term in this relation is a source of profit to the quacks. We feel all the more entitled to make this protest since we observe in the pamphlet sent us by the Society that they are great sticklers for the proper use of the term hypnotism.

The Edinburgh Exhibition in which, as our readers are already aware, it is intended to make a special feature of electricity, is passing through the preliminary stages of its existence in a highly satisfactory manner. A goodly array of patrons has been obtained, and an able and energetic executive committee has been chosen. An excellent site, easy of access, and of ample dimensions, has been selected at Merchiston. The guarantee fund has already reached the required sum of £20,000, and arrangements have been made for the transfer to Edinburgh of several important exhibits now installed at the Paris Exhibition. A good idea may be formed of the suitability of the proposed site when we mention that it is bounded on the north by the Caledonian main line, while the suburban railway of the North British Company intersects the grounds. On the south is the Union Canal, providing a ready water supply and the means for a fine display of electric launches. We trust an ex-

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hibition which promises so well will not be allowed to degenerate into an *omnium gatherum* devoid of special interest, and in which the lighter entertainments encroach unduly upon the heavier.

M. HOSPITALIER, who is a well-known purist in matters of definition and terminology, has just achieved a triumph in connection with the International Congress of Applied Mechanics, which sat last week in Paris. In the course of the proceedings a discussion took place on the practical unit of power, and it was decided to retain the *cheval-vapeur*. M. HOSPITALIER liked this but little, but what vexed his righteous soul far more was the flagrant misuse of the terms "force," "energy," "work," and "power," in which it seems nearly all the speakers indulged. By his influence a Committee was at once appointed to define, on behalf of the Mechanical Engineers, the precise signification of these terms. We do not greatly admire the mode of definition which has been chosen. The definition of Force is quite unscientific, whilst Work is defined with scholastic precision.

1. The word FORCE is to be employed only as a synonym of the word EFFORT, as to the exact signification of which there is no dispute.

2. The word WORK designates the product of a force by the path described by its point of application following its own proper direction.

3. The word POWER shall be exclusively employed to designate the quotient of a [given amount of] work by the time required to perform it.

BUT perhaps the most interesting feature is the recommendation of the Committee (afterwards endorsed by the Congress) to adopt the PONCELET as an alternative unit to the horse-power. The PONCELET is equal to 100 kilogrammetres per second, and it therefore follows that—

1 Poncelet = 0·981 kilowatt.

1 Kilowatt = 1·0193 poncelet.

It remains to be seen whether this permissive legislation will or will not remain a dead letter, but on this side of the Channel it is probably safe to prophesy that it will.

FROM the annual report of the POSTMASTER-GENERAL of Queensland we learn that the Telegraph Service of that colony has suffered severely through the prevailing drought of last year, and the consequent frequency of bush fires. Against these outbreaks the adoption of iron poles appears to be little or no protection, the lines being destroyed in many cases for several miles at a stretch. The wires are often fused into short lengths, and insulators broken through the poles becoming red hot. As, however, the iron poles maintain their ground they are decidedly superior to wooden ones, especially in a country like Queensland, where timber is sometimes very scarce; and the old wooden poles are now being rapidly displaced by iron.

THE course of lectures on electro-physiology and therapeutics which are now being delivered with marked success at the Institute of Medical Electricity by Dr. ARTHUR HARRIES and Mr. NEWMAN LAWRENCE is another instance of the good work which is being done by this institution in lifting medical electricity out of the region of empiricism and quackery. There are few more promising fields than that of electro-therapeutics, and we are not surprised to learn that these lectures are being well attended by medical men, many of whom have expressed the opinion that this course is just the thing wanted by those members of the profession who have not had the opportunity of making a special study of this important subject.

WHEN a man writes and publishes a book in this country he is not necessarily held to have performed a meritorious deed. On the contrary, he thereby presents himself as a suitor at the bar of Public Opinion (competent opinion, of course, if the volume be of a technical character), and unless his work can pass a careful and candid examination, the Author does not usually get off scot free. If he be adjuged guilty of adding to our groaning shelves a weak, or worthless, or inaccurate book, or even a merely unnecessary book, he suffers at the hands of the Reviewers the penalty of his crime. It is not so in America; in that great and free country, he whose name figures on the title page of a "scientific" treatise is accounted thereby a worthier man. Whether the book be good, bad, or indifferent, the reviews (with the rarest exception) are short and sweet; and the Author has only to swallow down the honeyed meed of praise. This, of course, fully accounts for the peculiar state of mind of an American correspondent whose letter will be found in another column. It is interesting to learn that the style of the book in question (confessedly adapted to infants of tender years) "has been to many of its older readers its great charm." We, too, were moved thereby, but we fear that our laughter was touched with a dash of cynicism. However, for those who like to take their "science" couched in the style and, as far as possible, in the language of the nursery, the "A B C of Electricity" will doubtless prove a charming work.

A CORRESPONDENT writes:—"There is a village not far from London which has recently been promised the blessing of the electric light. The district being a scattered one, overhead wires are to be used, and as a preliminary, several of the roads are now beautified(?) with 30ft. green wooden poles. Last week there was an indignation meeting touching those poles, at which one speaker, a decidedly small man, strongly protested against the statement that it would make the roads safer. His house, he said, was some half-mile from the station, the road lonely, and a policeman never seen at night. Now at present, he said, if he wore good big boots, who was to know by sound that he was not six foot two, and broad in proportion? When that road is brilliantly lit up, however, a tramp would not only see his real size, but also that there was no one else near, and finish him off without the slightest danger of being caught. No—the electric light would really be *very* dangerous at night."

WE are glad to be able to contradict the rumour current a few days ago that Mr. ALBION T. SNELL, of the firm of Immisch and Co., had met with a fatal accident in a North of England coal mine. The unfortunate gentleman who was actually killed under these circumstances, and who bore a similar name, was in no way related to Mr. A. T. SNELL.

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Aberdeen.—The Town Council has decided to apply for an electric lighting Provisional Order.

Hawick.—The Hawick Gas Company has asked the consent of the Town Council to its applying for electric light powers.

Dover.—A special committee of the Town Council has been appointed to consider and report upon the question of electric lighting.

Partick.—The report of the special committee of the Partick Board have advised the Board to decline to give their consent to any application for a Provisional Order.

Middleton.—The Middleton (Lancs.) Town Council has decided to oppose the application of the Municipal Electric Light and Power Corporation, for a Provisional Order.

Burslem.—It was resolved at the last meeting of the Town Council that application should be made for a Provisional Order to authorise the Council to supply the electric light.

Hastings.—A meeting of the Town Council is called for the 29th inst. to authorise an application by the Council for an electric-lighting Provisional Order for public purposes only.

Paris Exhibition Awards.—The Silver Medal obtained by Mr. Samuel Elliott, of Newbury, at the Paris Exhibition was awarded to him for wood-mouldings and electric wire casings.

Trade Catalogue.—Messrs. Winfields (Limited), of Cambridge-street, Birmingham, announce the issue of a comprehensive catalogue of new and original designs in Electric Light Fittings.

The Lighting of the City.—The special meeting of the Commissioners of Sewers to consider the proposals for lighting the City by electricity, announced for Tuesday last, will be held on Monday next.

Weston-super-Mare.—At the last meeting of the Board of Commissioners, the consent of the Board to the application by the Laing, Wharton, and Down Construction Syndicate for a Provisional Order was refused.

Conisboro'.—The inhabitants of Conisboro' are at present considering the question of the lighting their streets, and a section of the residents advocate making arrangements with an electric lighting company.

Bremen.—A Commercial and Industrial Exhibition for the north-west of Germany will be opened in Bremen in 1890. The section for gas, steam, and electric motors, as well as for tools and machines, will be international.

Govan.—The Govan Commissioners, after considering the report of the committee appointed in July last, have resolved not to make application for electric lighting powers, or to give their consent to any company applying for powers.

Canton.—A Chinese Electric Light Company has been formed to light the city of Canton, with a capital of $400,000. It will be the first electric light plant ever placed in China. The machinery is to be purchased in the United States.

The Old Students' Dinner.—The fifth annual dinner of the old students of the City and Guilds Institute was held on Saturday last at the Manchester Hotel, Aldersgate Street. The number of those present was larger than usual, and the festivities were as successful as ever.

Electrical Engineering Appointment.—A statement appeared in our issue of October 4th, to the effect that Mr. Herbert E. Starr had been appointed to the Central Electric Lighting Station at Exeter. We are requested, however, to state that the appointment is only that of articled pupil.

Appointment Vacant.—The Electrical and Lighting Committee of the forthcoming Edinburgh Exhibition are advertising for an electrician to the Exhibition. The salary offered is £300 for the period from December 1st, 1889, to November 30th, 1890. Further particulars will be found in our advertisement pages.

Harrogate.—At a special meeting of the Town Council, held on Monday, the notices from the Laing, Wharton and Down Construction Syndicate, the Electric Construction and Maintenance Company, and the National Electric Supply Company were taken into consideration. A sub-committee was formed to deal with the question.

Sad Result of the Delay on the Spanish Land Lines.—A terrible illustration of the delays so common in the Spanish telegraph service has recently been afforded by the execution of a man at Ossuna, in Andalusia, whose reprieve was delayed on the wires, and only arrived at its destination after the sentence had been carried out.

L'Ingénieur-Conseil.—Our Belgian contemporary *l'Ingénieur-Conseil*, which has hitherto appeared fortnightly, has celebrated the twelfth year of its existence by commencing a weekly issue. The journal has also been considerably enlarged, and a comprehensive series of articles on the machinery and dynamos at the Paris Exhibition is announced.

Burglary at Messrs. Woodhouse and Rawson.—Two men were charged last week with breaking and entering the premises of Messrs. Woodhouse and Rawson, at 12, Sise-lane. The basement window was broken, and near the prisoners when they were arrested were found four gravity ammeters and 73 incandescent lamp globes. The prisoners were remanded.

Tenders Wanted.—The South Hornsey Local Board invite tenders for the construction and maintenance, for a period of seven years, of street fire-alarm posts, and connecting the same electrically with the fire station in Milton-road, South Hornsey. Tenders are to be sent in not later than the 12th November. Further particulars will be found in our advertisement pages.

House Lighting.—The mansion of Scatwell, situated on the banks of the river Conon, about ten miles from the Muir of Ord Railway Station, and belonging to Mr. W. G. Bell, has just been fitted with the electric light by Mr. R. F. Yorke. The current is supplied to a battery of accumulators by a dynamo situated about 200 yards from the house and driven by a turbine.

Portsmouth.—On the 18th inst., says the *Southampton Times*, the Roads and Works Committee of the Portsmouth Corporation will consider the notices of applications for licenses for the supply of the electric light in the borough. It is generally anticipated that the application of the Portsmouth and South Hants Electric Supply Company will be the one supported by the Corporation.

Luton.—At the last meeting of the Town Council a letter was read from the Municipal Electric Light and Power Corporation asking for permission to supply electric light to the borough. The application was referred to the Highways and Lighting Committee for consideration and report. The Midland House-to-House Electricity Company have already applied for the consent of the local authority.

Pontypridd.—At the last monthly meeting of the Local Board a letter was read from the solicitor of the Pontypridd Electric Lighting Company urging that the company ought to be given the power to run the wires overhead, the provisions of the Board of Trade being ample for the protection of the cable. It was unanimously decided to adhere to the previous resolution that in the town the wires should be laid underground.

The Electric Subway Railway Scheme.—The scheme for an electric subway railway, which was thrown out by a Committee of the House of Commons last year, is to be reintroduced in the coming Session, and an effort will be made to combine it with the new thoroughfare decided on by the County Council. The Council took exception to the railway last year, and it is hoped that they may take a different view if the scheme is brought forward again.

The Edinburgh Exhibition.—A meeting of the Executive Council was held on Friday. It was reported that, with the £500 voted by the Glasgow Corporation, the guarantee fund had reached the figure originally aimed at, viz., £20,000. It was agreed, however, to keep the fund open some time longer. It is anticipated that the Exhibition will be opened early next May. Sir Henry Isaacs, the Lord Mayor-elect, has accepted the office of President of the London Committee of the Exhibition.

Electrical Engineering Cards.—These are handy little pocket cards which are being issued weekly by the General Electric Company, and they contain a considerable amount of useful information in a small compass. Of the first three cards published, one gives Mr. Preece's Fuse Tables, and the other two give respectively in a compact form the prices and other necessary particulars of electric light casings and "Apostle" carbons. The General Electric Company will be glad to send these cards to anyone in the trade.

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Accumulators at the Paris Exhibition.—In addition to the silver medal awarded to the Electrical Power Storage Company for its system of distribution by means of accumulators, the following awards were made by the jury of the Paris Exhibition to makers of secondary batteries:—Grand Prize: M. Gaston Planté. Gold Medal: The Société l'Électrique of Brussels, who own the Julien patents. Silver Medal: The Société Française des Accumulateurs (Philippart Frères), who own the Faure-Sellon-Volkmar patents for France; M. Gadot, M. Émile Regnier.

Electric Lighting at Pontardawe.—Messrs. Paterson and Cooper have recently fitted up a very complete installation for Mr. Arthur Gilbertson, of Pontardawe. The plant comprises a 16 horse-power nominal engine, a locomotive boiler working at 90lbs. pressure, and two "Phœnix" dynamos belted direct to the engine. One 120-light machine supplies current to All Saints' Church and to Mr. Gilbertson's residence, Glamloyd, nearly a mile distant. The other machine, a 300 lighter, supplies current to the tinworks, which are lit by arc and incandescent lamps.

London County Council.—At the last meeting of the Council the Highways Committee reported that the Council on the 1st instant signified its disapproval of the works referred to in two notices given by the Kensington and Knightsbridge Electric Lighting Company. The principal cause of objection had now been removed, as with the present amended notice the company had sent in plans showing that the sizes of the straining-up and service boxes to be used had been considerably reduced. The committee recommended that the Council should give its consent to the works referred to.

Telegraphic Communication with Mauritius.—Considering the importance of the trade of Mauritius, it is curious, says the *Financial Times*, that the island is still without telegraphic communication with the rest of the world, although the extension of the African cable to the place has been talked about for years past. The owners of such a line would net quite a good income by conveying information respecting the disabled vessels which are constantly seeking a refuge in Mauritius. It would almost pay the underwriters at Lloyd's to connect the island with the mainland out of their own pockets.

The Sellmann Electric Signal for Ships.—A new signal light, the invention of Lieutenant Sellmann, of the German Navy, was tried at Devonport last week. This method is a combination of three electric lights. A number of messages were exchanged between the Seamen's Barracks and H.M.S. "Defiance," and the experiments were watched by the Naval Commander-in-Chief, Admiral Sir W. Dowell, K.C.B. As a result of the experiments, Lieutenant Sellmann's invention is very highly spoken of, but those competent to judge assert that the present lamp in vogue in the navy, the Colomb lamp, has many and decided advantages over it.

Tenders Wanted.—The Municipal Commissioner for the city of Bombay will be prepared to receive tenders, on the 9th January, 1890, for the experimental lighting by electricity of the main road from the Crawford Markets to the end of the Apollo Bunder. Firms willing to undertake the experiment (for which no longer period than two years will be guaranteed) are asked to submit full particulars as to the system or systems which they may propose to adopt either wholly or in part, the number and position of lamps to be erected, the illuminating power, and the rates to be charged monthly. Further particulars will be found in our advertisement pages.

Copper.—The September copper statistics are less favourable than those for previous months, the reduction in the visible stocks during the month being infinitesimal. The deliveries aggregated only 9,436 tons, against 13,923 tons in August, and as the receipts during September were 9,120 tons, the stock was only reduced by 316 tons, leaving it on the 1st of October 105,669 tons. So far, the price of copper has been maintained at a price in excess of that which obtained when the stocks of that metal were less than one-half of their present weight, but the diminution in consumption, if continued simultaneously with the present large output, cannot fail to compel a considerably lower range of prices.

The Electric Light at the Exeter Theatre.—The Theatre Royal was opened last week. The house is almost entirely lighted by electricity, very little gas being used, and none whatever on the stage. The current is supplied by the Exeter Electric Light Company from their works, situate in the New North-road, about 250 yards from the theatre. The stage is lighted by means of batten, side and proscenium lights, there being in all six adjustable battens, each carrying 40 16 candle-power lamps, with fusible cut outs attached to the ends of each batten, the lamps being protected by a light wire frame fixed to batten. The side-lighting is effectually supplied from 10 lamps, arranged in a vertical row on each side of the stage. A row of 50 lamps supply the front or proscenium lighting. The flys are lighted by 8 single lamps, secured to the walls on either side by neat brass brackets. The auditorium is now lighted by 20 lamps, suspended from the dome, but these are to be replaced by a 50-light electrolier. Other lights are placed in different parts of the house, the total number of lamps used throughout being about 500.

St. James's Vestry.—At the last meeting of this Vestry the Lighting Committee recommended "that the London Electric Supply Corporation should be informed, with reference to their notice of intention to lay mains in certain streets, that the Vestry have no desire to oppose the commencement of operations on technical grounds, but that, before approving any plan or giving consent to any such work, they feel it their duty to ascertain that the preliminary obligations of the Provisional Order have been complied with, and would therefore be glad of information as to whether the Corporation have yet satisfied the the Board of Trade, and are in a position to fully and efficiently discharge the duties and obligations imposed upon them by the Order; whether they have yet deposited or secured the sum prescribed by the seventh section, and what steps they have taken in the matter of providing a second generating station." The Clerk read a letter from the Board of Trade stating that they were still in communication with the company on the subject; and one from the company stating that the negotiations would be settled in the course of a few days. It was moved that the whole matter be referred back to the Committee, to obtain further particulars regarding the company's position. The motion was carried.

Messrs. Woodhouse and Rawson's New Wiring Tables.—In compiling and publishing the set of Wiring Tables which have just been issued by Messrs. Woodhouse and Rawson we do not hesitate to say that this firm has conferred a distinct boon upon the electrical community. The preparation of Tables of this character must always be to a certain extent an affair of compromise; the problem to be solved is that of conveying the fullest and most accurate information in the most readily available form, and in small compass. In these Tables we are of opinion that this end has been more fully obtained than ever before. The following are the questions to which the Tables are intended to furnish an answer:—

1. To find by inspection the cable to use for a given current and current density, with a fall of potential of 2 volts.
2. To find the correct cable to use for a given current, with a given current density and a fall of potential of N volts.
3. To find the correct cable to use for a given length and current, allowing a fall of 2 volts.
4. To find the current density when any cable is employed for a given current.

In addition the Tables give the number of 50-volt and 60-volt lamps corresponding to the given current, the necessary correction (furnished by Mr. Mordey) for alternating currents of given frequency, and they show by larger type the current for each cable which corresponds to a density of 1,000 amperes.

The Cousens' Electrical Process for Extracting Gold.—On the occasion of a recent visit of a party of gentlemen interested in gold mining to the works of Messrs. R. Hornsby and Sons, of Grantham, the Cousens' electrical process for extracting gold was inspected. The ore, after being crushed by the stamp battery, passes through metallic rollers, which catch up any iron substances that may be in the ore or quartz, and proceeds into a large barrel strengthened by iron bands. Some inexpensive chemicals are introduced into the barrel along with the pulp, and the barrel rotates whilst a current of electricity is passed through it and the ore. In about an hour's time the pulp is released, and flows into a large pan having rotatory fingers, and afterwards

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proceeds in the ordinary way through riffles on to the plates. From the pan the pulp flows over amalgamated plates, and subsequently over blanket strakes, the plates being kept clean by rubbers, supplemented by electrical activity. The rubbers are carried by endless chains, and, while these are connected to the positive pole, the plates are connected to the negative pole of a dynamo or battery. The process was put to a severe test as the ore which was passed through was almost entirely pyrites, and practically free from quartz. Mr. Cousens' process is considered by the *Mining Journal* to be both ingenious and, on the face of it, applicable to refractory ores.

Alterations in the French Telephone Tariff.—The charges made for the use of the public telephones are to be modified. The price for five minutes' use of the telephone for Paris is to remain unchanged at 50 centimes. For the use of the long-distance wires the charge will be variable, according to the distance, and will be calculated at the rate of 50 centimes per 100 kilometres for every five minutes' conversation. Thus the charge of three francs now made for five minutes' conversation between Paris and Marseilles will be raised to at least four francs, as the distance separating the two places is over 800 kilometres. On the other hand, the price for the use of the telephone existing between Rouen and Paris will be reduced to 1 franc 50 centimes.

St. Pancras Vestry.—The Parliamentary and Lighting Committee of St. Pancras Vestry have had recently before them several notices of intention to apply for electric lighting Provisional Orders. After considering the matter, the Vestry have decided to send a reply to the effect that, the Vestry having an Order under the Electric Lighting Act, have referred the same to a committee with a view to make inquiries and to obtain estimates for the establishment of electric supply under the Vestry's own control, and that, until the Vestry have received and considered the committee's report, they are not prepared to entertain the consideration of the notices. Mr. T. B. Westacott, a member of the Vestry, has reported that the estimated cost of supplying the parish with electricity would be at first £50,000.

A New Storage Battery for Tramway Work.—The following is the description of a storage battery for tramway purposes, which has recently been brought out by the Société l'Electrique of Brussels. The battery consists of hollow cones of lead 30cm. in diameter, 20cm. high, and 3mm. thick. The external surface of each cone carries a number of projections, which serve the double purpose of supporting the active material and of keeping the cones apart. The internal surfaces are covered with litharge, and the external surfaces with minium, and thus each cone plays the double *rôle* of positive and negative plate. The cones are mounted one inside another, and the spaces between them filled with sulphuric acid, the projections forming the contacts. A high output for weight is claimed for this battery.

Exports of Electrical Apparatus.—The Board of Trade Returns for September show that our exports of electrical apparatus during the past quarter were below the average. The aggregate value of our exports to date is still higher than it was in 1887 and 1888, but the falling off during the last few months is rapidly wiping out the exceptionally favourable comparison of the first six months. The following is a comparative statement for the past three years :—

	1887.	1888.	1889.
January 1 to June 30 ...	£188,812	£244,213	£576,456
July	195,950	21,571	32,909
August	114,162	110,323	46,452
September	158,140	21,032	38,099
Nine months	£657,064	£397,139	£693,916

The Ries Traction Increaser.—The electric traction increaser devised by Elias E. Ries, of Baltimore, has just been tested with satisfactory results, says *Engineering News*, on the Philadelphia and Reading Railroad. The trials were made on the Frackville grade, 185ft. per mile. The apparatus, it will be remembered, consists of a small dynamo and engine mounted upon the locomotive and furnishing a current, which is passed from the forward to the rear driving wheels, through that portion of the track rails lying between them, causing an increased friction between the wheels and the rails. This arrangement is claimed to be far superior to sanding the tracks. With the dynamo running and a train of 45 cars attached to the locomotive, the ascent was made in 28 minutes, while without the current a trip over the same ground, with the same train behind, required 55 minutes.

Underground Electric Lighting Cables in the Strand.—During the past week or so Messrs. Siemens have been laying a cable on the south side of the Strand for the London Electric Supply Corporation. The cable is a concentric one, the insulation between the central and tubular strands being a fibrous material saturated with paraffin wax. Over the tubular strands follows a waterproof compound and an iron sheathing consisting of ribbon wound on spirally, and then hemp outside. The over-all diameter is about 2½in. The cable is laid in a trench about 9in. wide and 12in. deep cut in the footpath. Certainly, for cheapness and simplicity in laying, this system leaves nothing to be desired—at least, when the cable passes above the buried tangle of drains, water and gas service pipes, &c., as in this case. How such cables will fare when the British labourer with pickaxe and shovel appears on the scene it remains for experience to prove.

Reforms in the Cuban Telegraph Service.—Spanish advices from Cuba state that General Salamanca, the Governor of the island, has issued a decree, subject to the confirmation of the Home Government, introducing modifications into the service. It is proposed to cancel the existing tariff for interior telegrams and to substitute the following scale, viz.:—telegrams from 1 to 10 words, including address and signature, 20 centavos (1 centavo = ½d., about); 10 to 15 words, including address and signature, 40 centavos, and 5 centavos for each additional word, whatever be the length of the telegram. It is also proposed to receive urgent telegrams at three times the ordinary rate! The progress of telegraphy in Cuba evidently leaves much to be desired. Prepaid replies to the extent of 30 words will be allowed. The use of the French and English languages will be allowed, and the prohibition of the use of telegraph codes for the interior, under the decree of December 20, 1876, will be withdrawn.

Telegraphic Communication between Liverpool and Havre.—A discussion recently took place in the Havre Chamber of Commerce respecting the delay in establishing direct telegraphic communication between that place and Liverpool. M. Coupery, who brought the matter forward, explained that the dispatch of telegrams to either Hamburg or Bremen only took three-quarters of an hour. A message might go from Liverpool to Mulhouse, by using the Bremen route, in an hour; but between Liverpool and Havre it took from four to five hours. M. Rispal said that the establishment of direct telegraphic communication between Liverpool and Havre was one of the conditions of the arrangement come to between France and England for the working of the sub-marine Channel lines. After some further discussion, the Chamber decided to write to the Minister of Commerce, pointing out this unsatisfactory state of things, so prejudicial to the trade of the port of Havre, and soliciting his intervention to remedy the same.

Obituary.—Major-General Robert Murray, R.A., C.S.I., of the Bengal Staff Corps, late Director-General of Telegraphs in India, died on Saturday last at Ryde, Isle of Wight, at the age of 60. He entered the Hon. East India Company's service in the Bengal Artillery in June, 1845, serving in the Punjaub campaign of 1848-9, taking part in the action of Sadoolapore, in the battles of Chillianwallah and Goojerat, and in the advance to Peshawur. He received the medal with two clasps for these services. From 1857 he was employed in the Indian Telegraph Department, and from 1878 till 1883 was Director-General of Telegraphs in India. He became a colonel in 1876. In 1884 he was created a C.S.I., and in 1886 was advanced to the rank of major-general, when he was placed on the supernumerary list.—We regret to learn of the sudden death, on October 3rd, of Mr. Henry Sach, Telegraph Superintendent Great Eastern Railway, at the age of 60 years. The deceased had been superintendent of telegraphs for 43 years in the service of the Electric and International Telegraph Company, and since the transfer of the telegraphs to the Government he had been with the Great Eastern Railway.

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THE BIRMINGHAM EXHIBITION.

THE SNELGROVE ELECTRIC WEIGHING MACHINE.—This weighing machine, the invention of Mr. William Snelgrove, is manufactured by Messrs. W. and T. Avery, of Birmingham, and may be described as a self-balancing, self-indicating weighing machine of the knife-edge steelyard type, which, as is well known, is the only form of weighing machine that can with safety be depended upon for accurate results. By the aid of electricity Mr. Snelgrove has succeeded in combining this accuracy with the self-indicating advantages of the spring balance. The machine exhibited at Bingley Hall indicates up to 10cwt. and shows variations of 1lb., and the general construction of it is shown in Figs. 1 and 2. The steelyard or beam B (Fig. 2) rests on the knife-edge centres, K, and the weighing platform is hung from the rod W. The balance weights consist of riders or poises, R and P, running on small wheels, and are driven along the guide rods by means of the motor shown in Fig. 1. They come to rest when there is perfect equilibrium, and their positions are indicated by figures painted on revolving dials, similar to those of an ordinary meter. There are two poises or riders in the machine—a small one, R, for indicating pounds, and a large one, P, for quarters and hundredweights. The position of the former is indicated by the dial-circle C_1, that of the latter by the large circle C_2. To prevent undue oscillations a brake, V, is introduced, which presses against the end of the arm A, which is rigidly attached to the beam; the brake is under the control of the electro-magnet D, and the pressure can be regulated by the small adjustable weight E.

Each poise has spur teeth cut on its under side which gear into a small wheel driven by the motor, and ratchet teeth on its upper side which engage with a pawl fixed to the beam. The use of this ratchet and pawl is to prevent the backward motion of the poise which would result from the compression of a spiral spring, which is wound up during the outward travel. The gear wheels, of which there is one for each poise, are loose on a spindle driven by the motor, and each wheel is set in motion by means of a clutch controlled by an electro-magnet. Fig. 3 shows one of these clutch magnets, with gear-wheel, rack, &c. As will be seen, the clutch H is thrown in and out of gear by the arm L worked by the magnets O or P. When a weight is placed on the platform one end of the beam rises, and with it the arm A (Fig. 2); this causes a contact with the terminal T_1 which is fixed to the support or carrier S attached to the base of the machine. An electrical circuit is now closed, which includes the brake magnet D, the motor relay and the small poise clutch magnet. The motor begins to drive the small poise along its guide, which continues to travel outwards until it strikes the switch lever F, which throws its own clutch magnet out of circuit, and puts into circuit that of the large poise, which in turn begins to travel outwards until the weight is lifted and the beam B drops. Contact with T_1 is now broken and made with T_2. The large poise clutch is now thrown out of gear, and remains stationary, being held in position by means of the pawl already mentioned; at the same time the small poise pawl is released, and the poise itself travels slowly back again under the action of the spiral spring, which now unwinds. This backward motion continues until equilibrium is established, when the arm A stands between T_1 and T_2,

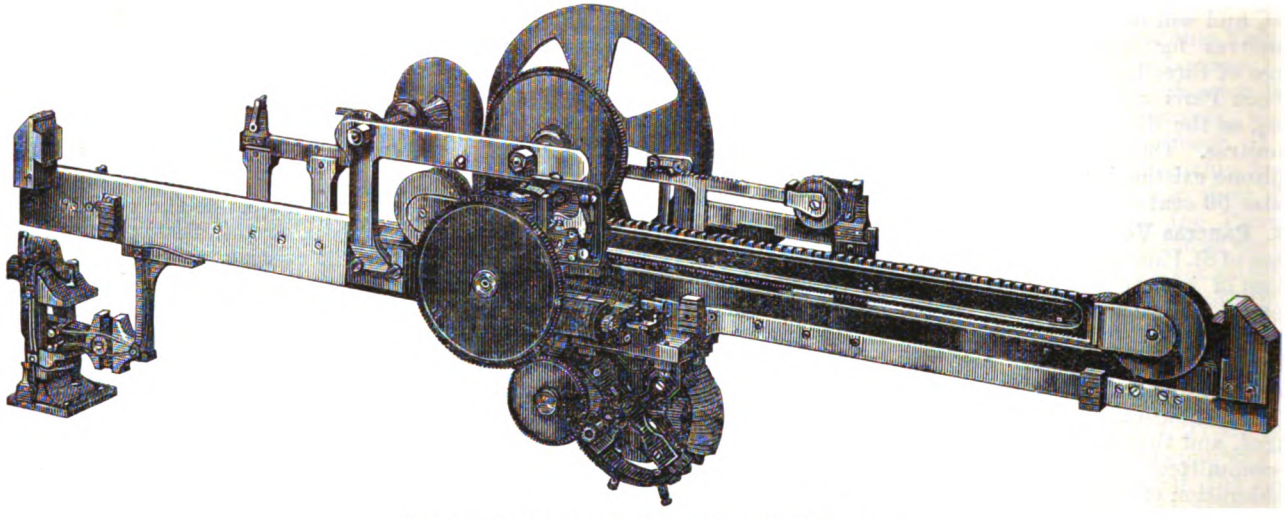

FIG 1.—Snelgrove's Electric Balance (Back View)

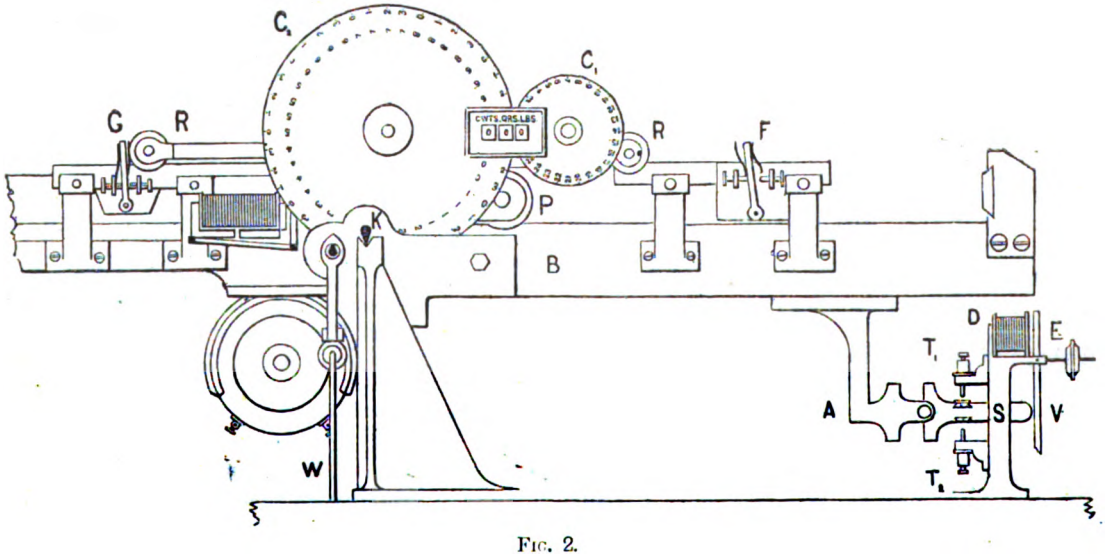

FIG. 2.

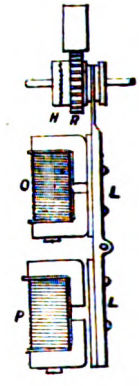

FIG. 3.

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all circuits being broken and the weight being indicated by the dial circles. If the load on the platform is too heavy for the machine, the large poise runs to the end and strikes a switch, breaking the electrical circuits and bringing everything to rest. When the weight is removed from the platform, the beam drops on to the contact T_2, the small pawl is again released, and the poise R travels back, and on reaching the end—its original position—moves the switch G, which now releases the large poise pawl, allowing it also to travel back, when it finally touches another switch, and breaks the electrical circuit entirely. It will be seen, therefore, that the whole arrangement is entirely automatic, and cannot come to rest until equilibrium is established and the weight correctly given on the dials. The whole process of weighing is completed in a very short space of time, considerably less than that required for working the ordinary weighbridge and steelyard machines in everyday use. The power required by the motor is very small, a few Leclanché cells being sufficient to work it, and as the electrical connections and switches are automatically controlled by the mechanism no skilled attention is needed to operate the machine.

SAYERS AND STURGE'S SUSPENSION FOR ELECTRIC LAMPS.—An ingenious and simple arrangement devised by Messrs. Sayers and Sturge is exhibited for the suspension of arc and incandescent lamps. Its object is the avoidance of the dangling

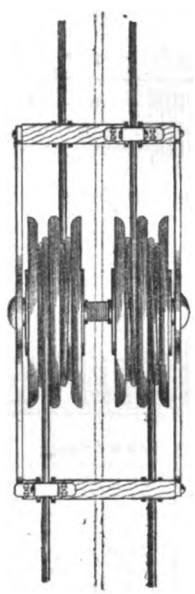

FIG. 4 (front view.)

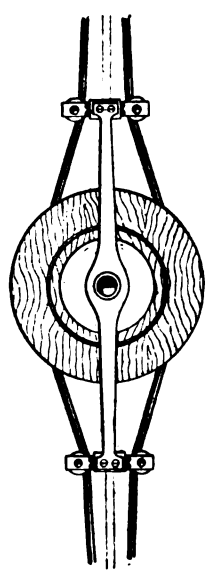

FIG. 5 (side view).

cords and swinging leads that usually accompany arc lamps and electroliers when they are required to be pulled up and down. For arc lamps the device takes the form of a block shown in Figs. 4 and 5, for glow-lamp electroliers it slides up and down a central guide bar. As will be observed from Fig. 4, there are two blocks round which the leads are wound, each block having two grooves turned in it with a flange between. The flexible lead is wound in one direction round one half of the pulley, then passed through a hole in the flange and wound round the other half in the reverse direction, and is thus carried down to the lamp without any joint or sliding contact. When an arc lamp is lowered, or an electrolier pulled down, the block descends through half the distance. The leads are re-wound when the lamps are pushed up, by the action of a flat spiral spring fitted inside the block.

BOOKS, &c., RECEIVED.

Price List of Electric Light Cables and Wires. W. T. Henley's Telegraph Works Company (Limited).

Revised Price List of the Sunbeam Lamp Company.

"The Law Relating to Electric Lighting." Second Edition. By G. Spencer Bower and Walter Webb. (London: Sampson Low, Marston, Searle and Rivington.)

"La Lumière Électrique." By L. Montillot. (Paris: J. B. Baillière et Fils.)

DISTRIBUTION OF ELECTRICITY IN CHELSEA, &c., WITH ACCUMULATORS AS THE MAIN SOURCE OF SUPPLY.*

BY MAJOR-GENERAL WEBBER, C.B.

(Concluded from page 483.)

DESCRIPTION OF THE AUTOMATIC REGULATOR OF THE ELECTRIC POWER STORAGE COMPANY.

The charging mains arriving from the generating station are divided and connected to the groups of mercury cups of two "*charging circuit relays.*" These relays, C_1 C_2 (see Fig. 8), are identical in construction, and are really rocking switches, and come into action at the moment when the half batteries are just in or out of charge. Their function is to introduce into the charging circuit a carbon resistance, O, between the time that one half battery goes out and the other enters the position of being "under charge." The groups of four cups on the outsides of these relays are half positive and half negative, and the relative positions of the arms incline in the same direction. To pull them into those positions and maintain them there, each arm is actuated from below by two electro-magnets placed in a local circuit, to which I will refer further on. When the right-half battery S_1 is in charge, the right relay C_1 is in contact on its right (as it presents itself on the diagram). The positive and negative cups are respectively in connection with corresponding cups on the outside of the right-hand *transposing switch* A_1. The intermediate terminals are severally connected with the poles of four sets, each of 54 cells, so that these 216 cells are in circuit in series. On the way to the right-hand *charging circuit relay*, the positive conductor has formed the coils of a *charging solenoid*, marked E. Its function is as follows:—When the current is passing, the solenoid closes a valve in connection with a little gasholder, F, used to collect the hydrogen gas formed by one plate in one of the cells under charge. This cell is called a *master cell.* When no current traverses the coil of the solenoid, the valve is open, and no gas is retained in the holder. At this point the duty of the holder F may be described. When the half battery is approaching full charge, gas is given off, and the valve alluded to being kept closed by the charging current, gas is retained by the holder, and commences to fill it. The gas given off is collected first in an ebonite *gas chamber and acid trap*, marked H. The trap prevents any gas from this particular plate going anywhere else than into the gas chamber. From the *chamber* the gas passes into a bubbling-bottle, G, with oil in it, which is intended to extract the moisture, and thence to the little holder. The size of the holder is calculated so as to contain just sufficient gas as will be given off by one plate after the proper state of *milkiness* of the cell has been attained. The moment it fills, a contact is made with the arm of a switch which is underneath it. The switch closes the *local circuit*, to which I have already alluded as actuating the pulling-down magnets of the charging circuits C_1 C_2.

To return to A, the right-hand *transposing switch.* Let it be remembered that its right-hand contacts are dipped in their cups and the left-hand contacts are elevated out of them, and the charging current can go nowhere else but through the half battery. Meantime, discharging into the lamp system is going on from the left-hand half battery, and while this is going on the right-hand contacts of the rocking arm of the left *transposing switch* are dipped. These contacts are so arranged and connected with the poles of the four sets of cells that they are in position to discharge in parallel. It is evident that when the positions of the rocking arms of the two transposing switches A_1 and A_2 are reversed, the left half battery will be "in *charge*" and the right half battery discharging; and, again, that if the inner ends of the two rocking arms are dipped and they stand with opposing angles, then both half batteries are discharging, and charging has ceased.

Let us return to what takes place at the moment the arms of the switches rock into a fresh position. Underneath each of these arms, as in the case of those belonging to the charging circuit relays C_1 C_2, are placed two electro-magnets to pull them down. These electro-magnets are also placed in the local circuit mentioned twice before. This operation of rocking over, so to speak, is sufficiently slow between the break and make in the mercury-cups as to allow an interval of disconnection of less than half a minute. During this interval the charging current does not cease, but for the time, as has been already described, is relayed through the resistance O by the operation of the *charging circuit relay* C_1, the rocking arm of which, instead of moving slowly like that of the *transposing switch*, moves instantaneously. The operation is effected in the following order and manner:—As has been stated, the gasholder closes the local circuit in the pull-magnets under the elevated end of the rocking arm of the right-hand transposing switch, which com-

* Paper read before the British Association in Section G, Newcastle, September, 1889.

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mences to move slowly over, aided by a balance weight rolling in a groove on its upper side. As the charging contacts leave the mercury other contacts under the arm break the current in the pull-down magnet of the outer and of the *rocking arm* of the *charging relay*, which, being weighted, falls the other way, and effects simultaneously the introduction of resistance, O. The rocking arm of A A_1 continues moving slowly over. It first makes the contacts, which bring the right half battery into the position of discharge in parallel, and finally makes other contacts, which, acting on the local circuit through a small rocking switch, starts the rocking arm of the *transposing switch* A_2. Its first action is to cut the left half battery out of the lamp system, and when it completes its journey to throw the left half battery in series into the charging circuit. At the same moment, by a separate contact, it closes the local circuit which actuates the pull-down magnet of the charging-circuit relay C_2, the effect of which is simultaneously to transfer the charging current from the resistance O to his next duty. When the left half battery is charged, the next and final stage is carried out by the gasholder acting as before on the local circuit, the work of which is confined to inciting the rocking arm of the left-hand *transposing switch* to rock over, so that the second half battery goes to the assistance of its fellow. A tell-tale wire back to the generating station from the transposing switch actuates a relay at the generating station the moment that the left-hand contacts lift out of the mercury. The current so transmitted actuates a relay which cuts off steam at the generating station.

of a carbon filament which is in circuit with the coil of M. This alteration of length, which minutely varies the resistance, is caused by the expansion and contraction of alcohol in a bent glass tube which presses on a column of mercury, into which one end of the filament is inserted. As the bulk of the alcohol alters through temperature the mercury is pressed up or down, and less or more of the filament is short-circuited. In order to maintain an equal discharge from each half battery, a *current balance*, marked K, is used. This apparatus is made of two coils of large section copper, wound spirally apparently, but really cut out of a piece of copper tube. The whole current from each half battery passes through one of these. Should one half battery be giving current at such a rate as to run some 10 per cent. below the other, the coil acts solenoidically and completes the circuit in D_1 or D_2, whichever may be affected, and thereby, through the intervention, as before, of one of the resistance switches B, cuts out one of the counter E.M.F. cells. The reduction of counter E.M.F. to the half battery which has been under discharging at once brings the two half batteries up to the same line. The diagram shows at two places the connection to which the feeding mains of each kind are led. At T is placed an ammeter to measure the total discharge into the feeding mains, which can be cut in or out. At the other pole is shown a set of safety fuses; these are also used on the other pole.

Of course there are many minor very important and interesting features of this beautiful invention of Mr. F. King's to which I have no space to allude. The small relay, marked N on the drawing,

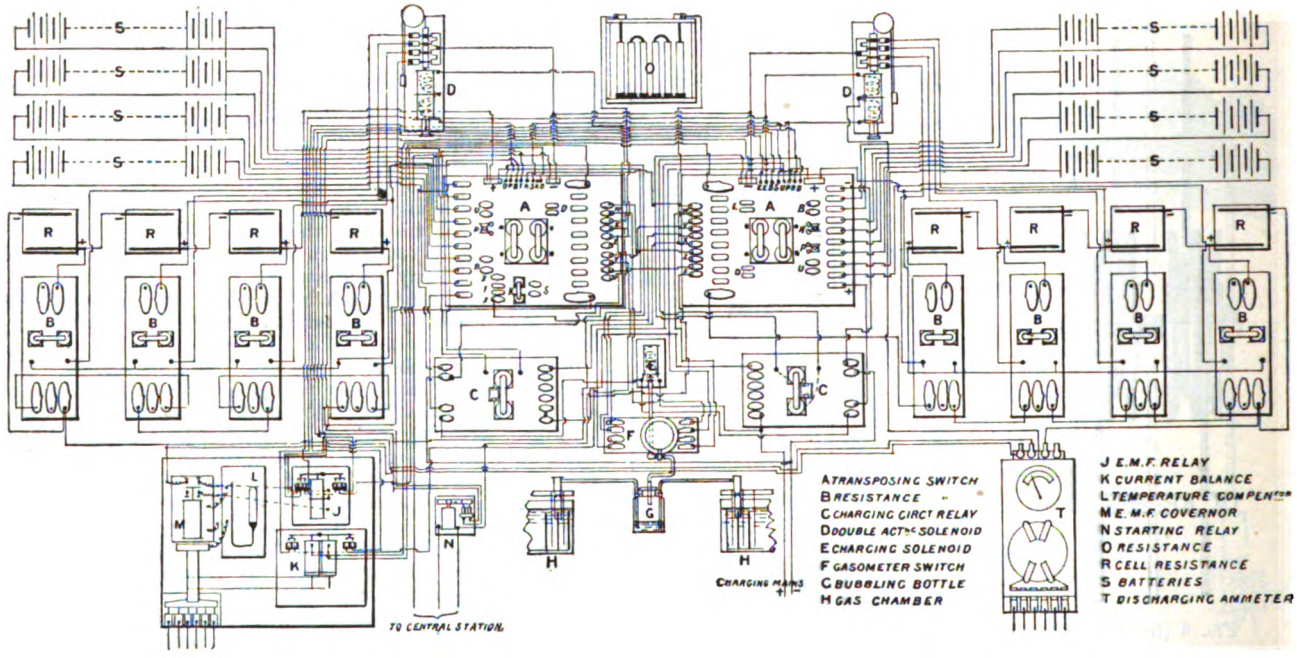

FIG. 8.—Automatic Regulator of the E.P.S. Company, as employed at the Chelsea Sub-Station.

On each side of the diagram are shown four resistance cells of the same type as those for accumulating, marked B, etc. The duty required from them is as follows:—1. To supply counter E.M.F. with which to regulate the pressure in the lamp system. 2. To give the required energy to actuate what has several times been referred to as the local circuit, of which there are actually two—one for each side of the apparatus.

This brings us to the consideration of what occurs in discharging from the batteries. In a system requiring a pressure of 100 volts, varying 1½ per cent. above and below, that from 54 cells is excessive, even allowing for the fall between the station and the ends of the feeders. At the same time it is necessary to have ample reserve to meet occasions of heavy discharge. To keep the pressure constant at the ends of the feeders, there must be tell-tale wires from those points to the E.M.F. governor M, fixed on the governing board. This apparatus is a fine wire coil in parallel with the feeders, and its function, when the E.M.F. is above or below the normal limit, to move a solenoid up and down. A lever bar connected with this completes a local circuit in a relay marked J, which in its turn actuates the two double-acting solenoids D_1 and D_2, which operates simultaneously on sliding contacts in connection with *resistance* switches B_1 B_1 B_1 B_1 and B_2 B_2 B_2 B_2. These solenoids act as rheostats on the discharging circuit, by putting in or taking out the counter E.M.F. cells one at a time, and even two at a time. The E.M.F. governor M is also in series with a temperature compensator, marked L. This little apparatus keeps constant the resistance of the fine wire coil of M by altering the length

has not been described, but I think it desirable to call your attention to it, not with the object of including it in the description, but in case any question may be asked about it. It completes the local circuit and causes switch A_1 to be brought into position of charge. It is actuated by a current from the generating station when the engineer is ready to start charging.

It is claimed for the system which has been under description:—That the cost of the *generating* and *storage* plant does not exceed that of any other system. In support of this, I have a calculation before me, made by the Electric Power Storage Company for a generating and storing plant for 30,000 30-watt lamps at £45,000, or at the rate of 30s. per lamp. On the same lines, the actual cost in Chelsea for a 9,000-lamp plant has been 40s. per lamp. Under the best conditions, the generating plant itself need not exceed an indicated capacity one-half of the maximum capacity of the system, assuming that the proportion of energy for which the consumers will pay is at least 70 per cent. of the energy produced at the terminals of the charging dynamos. The economy in space thus acquired is equivalent to the demand for space for storage. It is also claimed that the cost of the mains is less than in any other system. And, again, it isclaimed that the *working cost* must necessarily be considerably below that of any other system on account of the working of the motive plant always at its full power. To this particular feature of the system I wish to draw marked attention, together with the economical advantages in working, arising out of the complete stoppage of the machinery in motion each day for periods varying according to the time of year.

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Specification of the General Conditions to be complied with in Wiring Houses for the Electric Light.

Compiled for the use of the Customers of the Chelsea Electricity Supply Company (Limited).

The contract under this specification includes all conductors commencing at the point where the Supply Company's work ends, and all electrical fittings which do not actually form part of the lamp fittings. It includes no lamp fittings unless otherwise specified.

1. Except where otherwise specified, the whole of the work to be carried out in accordance with the rules of the Society of Telegraph-Engineers and Electricians, and the Company in whose office the building is insured.

2. In every room or closet throughout the house one light will be separately controlled by a switch at the door, placed so as to be of easy access to the hand immediately the door is opened. In dressing and bed rooms this light will be suspended over the dressing-table, the length of the lead to permit of the lamp fitting being about 7ft. above the door. In other rooms the light to be so controlled will be selected as being the one most likely to be in common use.

3. No lamp lead is to be less in cross-section than the equivalent to a No. 18 S.W.G., and in the case of floor connections less than No. 16 S.W.G.

4. All mains and sub-mains where not carried between floor and ceiling, will be placed in approved wood casing. Where carried between floor and ceiling, they will be laid between the joists or in notches cut in the same, not less than 6in. apart, and in no case will any pair of leads be carried between the same joists or through the same holes in partitions, etc. They will be painted throughout with asbestos paint: positive red, negative black.

5. Wherever between floor and ceiling branches leave the main, they will be laid with sufficient slack, so that the branches shall not approach nearer to the main of the opposite pole than 6in., the necessary cleats being attached to, and holes bored in the joists to secure that end.

6. When the lamp leads serve lamps in rooms with wainscoting or ornamental walls, where casing is not suitable, they will be led separately and by different routes to the point where the lamps are fixed, following the lines of the molding or ornament; in such case they will be uncovered and fixed with saddles, and in no case, except where casing is used, may lamp leads approach nearer than 2in. of each other.

7. Where there are wall hangings or tapestry the lamp leads will be carried behind the same, if not in casing, as prescribed for, between floor and ceiling.

8. In the case of plain walls lamp leads will be laid in casings from the floor upwards, or the ceiling downwards, which will be let into channels cut in the walls. Should it be desirable not to disturb the decoration or paper, they will be laid on the face of the wall, and secured by saddles. In such case the colour of the covering of the conductor should harmonise as much as possible with the colour of the walls.

9. A wooden wall block will be fixed at every point where a lamp, wall plug, switch, or cut-out, are specified to be fixed under the contract, except where panelling or stone ornament already exists, when special means of attachment must be arranged for.

10. Distribution-boards will be supplied and fixed if required, and will carry the following fittings, besides the necessary terminals. To each circuit and sub-circuit will be furnished a switch and double-pole cut-out.

11. When a distribution-board is not required, a cut-out will be fixed at, or as near as possible to, the junction with each principal branch with the main.

12. Cut-outs will not be fixed at any other point in the system than those referred to in 10 and 11 except at each lamp.

13. Wall plugs, unless otherwise specified, will be fixed 2ft. 6in. from the floor, and where there is a dado they will be fixed above the top rail.

14. Floor plugs will make connection through a plate of insulating material laid flush with the floor, and the sockets will not be less than 3in. apart, and must be open at the base, so that dust may fall through into a cavity beneath.

15. Unless otherwise specified, the ends of the leads to serve lamps, of which the fittings are destined to be attached to the walls, will be left, so that the future fittings can be fixed anywhere between 4ft. 6in. and 7ft. above the floor.

16. Samples of all electrical fittings of every kind, and a drawing of the distributing boards will be submitted, and be subject to approval before being fixed.

17. Any deductions from, and additions to, the contract will be made only under instructions in writing from the superintending engineer, and no day work will be undertaken without his instructions; and no claim for such day work will be admitted unless a daily time-sheet for the same is handed to, or sent to him on the following day.

To this follow pages on which to draw up the number, nature, and position of the lamps, the descriptions of the route of each circuit, and a form of agreement to be entered into by the contractor.

Specification for the Supply and Laying Down Underground of Electrical Mains for the Chelsea Electricity Supply Company (Limited).

The contracting company is the Callender's Bitumen Telegraph and Waterproof Company (Limited).

1. *Route.*—The routes to be followed to be as nearly as possible those shown in the plans attached, but where necessary by reason of unforeseen obstructions they may be changed subject to the approval of the Chelsea Company.

2. *Excavation.*—The trenches to be made in the foot or roadways as the case may be to be on the routes described. The depth under the footpaths shall be as little as is consistent with safety. When under the roadways the depth of the trench shall be two feet under, or such other depth below the surface level of the roadway as the nature of the paving or macadam may require. When necessary, to avoid existing obstacles, pipes, &c., this depth may be increased or diminished, subject to the conditions of safety.

3. The existing paving of all kinds to be removed, and on completion of work replaced. The execution of the whole of this portion of the contract to be subject to the satisfaction of the surveyor of Chelsea parish, and to be carried out in terms of any orders or rules he may lawfully make, and to conform to conditions laid down in Clauses 13 to 19 inclusive, and in Clause 76 of the Chelsea Electric Lighting Order Confirmation Act of 1886, 50 Vic., cap. xviii.

4. *Open Trenches.*—The work to be so carried out that no one section of greater length than 100ft. shall remain open for 48 hours.

5. *Notices.*—All the notices which are laid down in the above-named Act as obligatory in connection with the works shall be given by the Chelsea Company, who shall relieve the contracting company of any responsibility in consequence of any neglect on the part of the Chelsea Company to comply with the requirement, but at the same time the contractors shall be required to give the Chelsea Company ample notice over and above the time of notices prescribed by the said Act to enable the Chelsea Company to fulfil its conditions; and, in case of the contracting company's defaulting to do so, the said company shall not be relieved from loss or responsibility arising out of any such failure on their part.

6. *Plans.*—The plans and drawings made in duplicate, as prescribed by the said Act, shall be prepared by the contracting company and delivered to the Chelsea Company.

7. *Deposit.*—Any deposit which the Vestry may require as a guarantee for the proper reinstating of the footpaths and roadways shall be made by the contracting company, and all arrangements connected with the same shall be made directly between the Vestry and the said company.

8. *Negotiations with Vestry.*—Although the Chelsea Company shall give all the legal notices required by the Act, or otherwise, the negotiations with the Vestry, their surveyor, or contractors, as to the actual mode and time of doing the work shall be carried on by the contracting company, advice of same being given to the Chelsea Company.

9. *Cable Cases.*—In the trenches as described, cable cases shall be placed and jointed together into continuous lengths. The cases shall be of the Callender-Webber type, of the sizes and with the number of ways as specified in the schedule.

10. *Cable Cases.*—The cases shall be made of the best bitumen concrete, of the same quality as those laid in 1887 at the Borough-road works of the Anglo-American Brush Electric Light Corporation (Limited). The thickness of material between the individual ways and between the ways and the outside of the case shall be at least half an inch. The inside of the ways shall be made truly circular in section and equal in area throughout, smooth and free from projections or roughness of any kind.

11. The cases shall be made in lengths of 6ft. each, the ends trued to fit each other, and they shall be jointed together by means of saddle-pieces and bitumen cement, and with the assistance of suitable mandrills for each separate "way," so that the ways shall be equal throughout and watertight, and the inside of the ways at the joints in every respect of the same section, within at least $\frac{1}{16}$th of an inch, as smooth and free from roughness as elsewhere. Tight joints shall also be made between the E.M.F. draw, and service, boxes, and the length of casing which join them.

12. No bends shall be allowed of a shorter radius than ——; they shall all be such as will allow the cables to be drawn in or out with ease, and the line of casing shall be laid out to avoid all unnecessary divergences from the straight or level. No curved

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length of casing will be used in which the circular section of the ways has been altered in form by the process of bending.

13. Drawing-in cords to be provided by the contracting company, and left in the ways as and when the cases are laid. When cables are drawn in, these cords to be used for drawing in the necessary drawing wires, which will be recoverable by or be returned to the contracting company, remaining their property in the interim.

Drawboxes.—14. Drawboxes to be provided at all points as follows:—

a. All changes in direction of line of 90deg. or thereabouts, or where changes of direction prevent the use of curves.

b. At all points of junction between one main and another.

c. Sudden alterations in level.

d. All straight lengths, in which boxes do not occur for the above reasons once in every hundred yards.

15. The drawboxes must be securely joined to the main casing. The covers of the boxes to be of cast iron, resembling the Post Office specification of weight and thickness, and to be of the designs, dimensions, and patterns agreed on between the managements of the two companies.

16. If during the progress of the work it is found expedient to place additional boxes, this shall be done by the contracting company on orders being given by the Chelsea Company.

17. *E.M.F. Boxes.*—The distributing or E.M.F. boxes to be placed at the points shown on the attached drawing and marked——, or elsewhere, if required. They will be constructed of brickwork in cement, or laid in bitumen, and with floors and covers of best York landing. They will be constructed on the general design shown on the attached drawing, modified to suit the particular conditions of each case. The copper junction pieces to which the mains are jointed will be of special design, suitable to each position, and the joints with the same, and their insulation shall be made in all respects as mechanically and electrically secure as the joints in the rest of the system, described elsewhere.

18. *Service-Boxes.*—Service-boxes to be of cast iron, and to be provided and fixed in number at least one for every two houses as shown in schedule. These to be of the design, dimensions, and pattern, agreed on between the two companies. Wherever possible only one line of distributing cables to be interrupted and pass through these service-boxes. Service-boxes and house connections to be fixed either at the same time as the casing is laid or subsequently, as found most convenient.

19. The cables used to be made as follows:

Conductor.—The strand to be of copper wire of high conductivity guaranteed not less than 98 per cent. that of pure copper. Each wire to be tinned separately and to be of the size shown in schedule.

20. *Dielectric.*—To consist of a solid sheath of bitite (vulcanised bitumen) put on under pressure to a diameter of not less than the dimensions named in schedule.

21. *Tapes.*—The cable to be taped over the dielectric three times with prepared tape and compounded between each. Braid to be of hemp yarn closely plaited and served with liquid bitumen compound, then with an asphalte compound, and finally passed through blacklead to facilitate drawing into the way. The cables to be coiled on large drums, having a boss of not less than 3ft. in diameter, and not to be subjected during manufacture or afterwards to any undue strain by bending or otherwise.

22. *Joints in Cables.*—The joints between the sections of the cables, each to each, to be made by a long soldered joint in the conductor. The seven central wires to be run together solid, and each of the outer wires to be individually jointed to the corresponding wire in the other cable, the wires to be short and long alternately on each cable to form a strong marriage joint. The whole to be then bound with fine copper wire and soldered over all.

23. This conductor to be lapped with tape, and then covered in not less than three thicknesses with sheet bitite, made specially for this purpose. The whole to be well welded together, and to be finally protected by strong prepared tape and compound.

24. Each joint when finished to be tested for insulation and conductivity. In each draw and distribution box a maximum of 2ft. and a minimum of 1ft. slack to be left on each cable for the purpose of allowing the sections of cable to be drawn backwards or forwards a few inches from time to time to prevent adhesion to the insides of the cases, and to secure their freedom, and the possibility of at any time withdrawing the cables for the purpose of maintenance.

25. *Service Joints.*—The joints of service leads to the mains for house supplies to be T joints, and made as described above, except that the service wire will be jointed on the main by passing through the centre of the main, and lapping three times round the strand, the whole to be then firmly soldered and insulated as before described.

26. In the service-boxes care to be taken that the joint is as near as possible in the middle of the space, so as to allow the cable being safely moved when drawn periodically backwards and forwards to prevent adhesion. The service-leads to have sufficient slack in the box to allow of this being moved without strain to the mains.

27. *House Connections.*—House connections to be provided from each service-box to within the boundary-wall of the premises, and such connections to consist either of a two-way Callender-Webber case, or of a cast-iron pipe carrying two cables, each of the size required to supply the current to be agreed on with the customers. A price to be paid for all such connections as shown in schedule. This to include breaking through and making good the house or area walls.

28. During the execution of the work the Chelsea Company to have free access for purpose of supervision to all parts of the work, and their representative to have the right to reject any labour and material which he considers in the interest of the work should not be employed, and upon receiving written notice to that effect from him the representatives of the contracting company will cease to use the same.

29. Every separate length of cable shall be tested for its insulation resistance after having been drawn into the casing and placed *in situ* before being jointed to the next length. The result of each such test must give infinity with a Wheatstone bridge, Post Office pattern both between the conductors and between each conductor and earth; the current used to have an E.M.F. not exceeding 100 volts.

30. The next test will be of the same lengths when jointed together from end to end from a station to a feeding-box. From this test the same result will be required.

31. Similar resistance results will be required from the distributing mains before the house-service branches are joined in as from the charging and feeding mains.

[The discussion on this Paper will be given in full in our next issue.]

OBITUARY.

DR. JAMES PRESCOTT JOULE.

It is with profound regret that we have to chronicle another loss to science in the death of the great physicist, Dr. Joule, which occurred on Friday last, the 10th inst., at his residence at Sale, near Manchester. He was born on Christmas Eve in the year 1818, so that he died in his 71st year. The name of Joule is familiar to every student of physics through its association with the mechanical equivalent of heat, which was first determined by him, and is, therefore, commonly known as "Joule's equivalent."

Owing to his delicacy as a child Joule was never sent to school, but was educated at home by private tutors until the age of 15, when he began working in his father's brewery at Salford. His first instruction in the elements of mathematics, in natural philosophy, and in chemistry was obtained from the great chemist, Dalton, famous as the originator of the Atomic Theory, which laid the foundation of modern chemistry.

There can be no doubt that Dalton's teaching exerted an important influence upon Joule's future line of work, and was an important factor in leading him to devote so much of his energies to throwing light upon the obscure domains of molecular physics. Very shortly after his introduction to Dalton he began to experiment with physical apparatus of his own construction, and in the year 1837, when he was only eighteen years old, he constructed an electro-magnetic engine, which he described in "Sturgeon's Annals of Electricity" of the following January. Two years later he discovered the fact that there is a limiting value to the magnetisation which can be communicated to soft iron by means of the electric current, and investigated the numerical value of this limit by determining the sustaining power of an electro-magnet excited by currents of different strengths. The results of these investigations were published in a series of Papers "On Electro-Magnetic Forces," which appeared in "Sturgeon's Annals." In the course of one of these Papers, he points out the great difficulty, if not impossibility, of understanding experiments and comparing them with one another, "arising from incomplete descriptions of apparatus and from the arbitrary and vague numbers which are used to characterise electric currents." "Such a practice," he says, "might be tolerated in the infancy of the science, but in its present state

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of advancement greater precision and propriety are imperatively demanded." This was written in the year 1840, and in his subsequent investigations he always employed a definite chemical unit of current of a value slightly less than two amperes. As unit of resistance he adopted that of a copper wire of definite dimensions, the variability in the resistance of different specimens of copper not being known at that time. These units were first described in a Paper "On the Heat Evolved by Metallic Conductors of Electricity, and in the Cells of a Battery during Electrolysis," published in the *Phil. Mag.*, in 1841. It was in this Paper that he showed that the heat developed by a current of electricity traversing either a metallic conductor or an electrolyte is proportional to the resistance of the conductor and to the square of the current strength. During the next three or four years Joule published a series of Papers describing investigations of the highest interest and originality, carried out with the experimental skill and minute accuracy in which he has always been simply unapproachable. The investigations opened up the hitherto untrodden fields of electrical and chemical thermo-dynamics. Want of space prevents our doing much more than calling attention to these Papers, but one important result obtained in them must be recorded, viz., that the total amount of heat evolved in a circuit composed partly of a metallic conductor and partly of a voltaic cell is equal to the total heat produced by the chemical action.

In a Paper "On the Calorific Effects of Magneto-Electricity, and on the Mechanical Value of Heat," communicated to the British Association at their meeting at Cork, in 1843, Joule proved that in magneto-electric machines mechanical work is converted into heat, and that the heat generated bore a constant ratio to the mechanical work absorbed. After this came the famous series of Papers in which Joule described in detail the experiments by which his mechanical equivalent of heat was obtained. These Papers are models of patient care, and of an accuracy which almost passes comprehension. The results described in them are too well known to require discussion here.

Among other important investigations of Joule's should be mentioned his research on "The Effects of Magnetism upon the Dimensions of Iron and Steel Bars," and his improvement of the tangent galvanometer by the introduction of a very small needle in place of the large ones previously employed.

Joule was an honorary D.C.L. of Oxford and honorary LL.D. of Edinburgh and Dublin, and a member, either honorary or ordinary, of a large number of scientific societies. In the year 1849 the Royal Society awarded him their Royal Medal for his celebrated Paper "On the Mechanical Equivalent of Heat," and it is worthy of note that this Paper, which was communicated by Faraday, was the first of Joule's Papers communicated to the Royal Society which was not rejected by them. Subsequently the Copley medal was also awarded to him.

Joule's work is remarkable, not only for its great accuracy in the most minute details, but for the deep insight into the processes of Nature which it exhibits, and for mathematical accuracy of expression combined with the almost complete absence of mathematical symbols.

The Physical Society has raised an enduring monument to this great leader of science by the publication of a very fine edition of his scientific Papers, compiled and edited by himself. The edition is in two volumes, the first comprising the Papers published by himself alone, and the second containing Papers which he published in conjunction with Sir William Thomson, Sir Lyon Playfair, and Dr. Scoresby.

SIR DANIEL GOOCH.

It is with deep regret that we record the death, after some weeks' illness, of Sir Daniel Gooch, Bart., which took place on Tuesday afternoon last at his residence, Clewer Park, Windsor.

Born at Bedlington, Northumberland, in 1815, he studied the profession of engineer at Newcastle under Robert Stephenson, and subsequently in the Tredegar Ironworks. In 1837 he became chief locomotive engineer to the Great Western Railway, after having been engaged under Robert Stephenson in his railway works at Warrington. He occupied this position for 27 years, at the close of which period he was elected chairman of the Board of Directors of the same company. The deceased baronet's public career is, however, mainly interesting on account of his having formed one of the small band of capitalists and engineers to whom we owe the establishment of telegraphic communication between this country and America.

In the year that Mr. Gooch became chief locomotive engineer to the Great Western Railway, the Atlantic Telegraph Company, disappointed by many failures, had become disheartened as to the chances of accomplishing their project of laying a cable to America, and confidence in the scheme was at the lowest ebb. The history of the company may be briefly told. It was projected in the year 1846, and six years were spent in its formation, as great difficulty was experienced in inducing men to support an enterprise considered by many utterly Utopian. The succeeding six years were consumed in abortive attempts to carry out the project, when at length the promoters were cheered by what seemed for a time the realisation of their labours. A cable was laid, and a message was sent from America to Europe, but communication soon ceased altogether. The cable was a failure. Another six years elapsed before the company were in a position to renew their efforts. Mr. Gooch was at that time a director of the Telegraph Construction and Maintenance Company, and in this capacity had given his attention to the subject of deep-sea cables; and he became convinced of the feasibility of the Atlantic cable project, and, having an interest in the "Great Eastern" steamship as one of the mortgagees, it occurred to him that the vessel could be utilised in carrying the cable out. The "Great Eastern" was sold for £25,000 over and above all liens upon her, Mr. Gooch being one of the purchasers. The "Great Eastern" Steamship Company was formed, with Mr. Gooch as chairman, and that company, the Telegraph Construction and Maintenance Company, Mr. (now Sir John) Pender, chairman, and the Atlantic Telegraph Company worked in unison. The "Great Eastern" sailed from England on July 15, 1865, carrying a cable of 5,000 tons. She sailed from the Thames, commanded by Captain (now Sir James) Anderson, Mr. (now Sir Samuel) Canning being in charge of the cable, and Mr. Willoughby Smith, chief electrician, with Sir (then Professor) William Thomson and Mr. C. F. Varley as consulting electricians, Mr. Gooch, Mr. Hamilton, and Mr. Cyrus Field being also on board. After connecting the cable with the land at Valentia, the "Great Eastern" steamed into the Atlantic on the 23rd July. Telegraphic communication with the vessel (interrupted by two faults due to defective insulation caused by pieces of metal pressed into the gutta percha coating, which were immediately repaired), finally ceased on August 2nd. The apparatus for raising the wire proving insufficient, the vessel returned. Subsequently the Atlantic Telegraph Company was reconstituted as the Anglo-American Telegraph Company (Limited). In June, 1866, the vessel sailed from the Medway with a new cable. The shore end at Valentia was spliced with the main cable, and the "Great Eastern" moved away on July 13th. By the 22nd of the same month 1,200 miles of wire had been laid. Five days later perfect communication had been established between Heart's Content, Newfoundland, and Valentia. The interest which Sir Daniel Gooch evinced in promoting the success of this great enterprise as Chairman of the Great Eastern Steamship Company and Director of the Telegraph Construction and Maintenance Company was promptly rewarded by a baronetcy. In addition to being chairman of the Great Western Railway Company and of the Telegraph Construction and Maintenance Company, Sir Daniel Gooch was a director of the Anglo-American, the Eastern and South African, and the Globe Telegraph and Trust Companies, and a Trustee of the Submarine Cables Trust. He was a deputy-lieutenant and Justice of Peace for Berkshire and represented Cricklade in the Conservative interest from 1865 to 1885. He was twice married, his second wife, who survives him, being a daughter of the late J. Burder, Norwood, Surrey.

Telephonic Extension in Hampshire.—The trunk line connecting Southampton and Winchester was opened last week. Three minutes' conversation is allowed for 6d. The trunk line between Portsmouth, Gosport, Bournemouth, Poole, Southampton, and Winchester will be completed before Christmas.

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The Electrician.

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THE PROFESSION OF ELECTRICAL ENGINEERING.

There was a time, and that not very many years ago, when the Church, the Bar, the Army or Navy, and perhaps the Medical Profession, were alone regarded as walks in life fit to be trodden by the sons of gentlemen. Engineering had not yet attained the rank of a Profession, but now it has become one of the most fashionable pursuits, and its many branches are crowded to an extent which makes anxious parents debate in their own minds whether, after all, they are doing right in allowing their sons to graduate for any one of them. The rapid development which has during the last few years taken place in electrical engineering, or to speak more correctly, the advent of this new branch of mechanical engineering, has naturally again raised their hopes, and the consequence is that in all institutions where technical education is given, the classes dealing with applied electricity are becoming more and more crowded. Ten years ago the English as well as the Continental technical schools did not include electrical engineering amongst the subjects taught. At the most there was given a course of mathematical or experimental physics, but of physics applied to useful arts—the theory of simple mechanisms, that dealing with the strength of materials and the theory of thermo-dynamics were the only subjects taught. Now a host of subjects, such as magnetism, electro-dynamics, electro-chemistry, the theory, and to a certain extent also, the practical construction of electrical machinery and apparatus have been added, the various schools and colleges recognising that to attract students it is necessary to give them tuition in that branch of engineering which at present is most fashionable because most promising. The popular tendency is decidedly in the direction of electrical engineering. Many an anxious father, who would not dream of making of his son a civil or mechanical engineer of the old school, will unhesitatingly

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send him to a college which professes to turn out full-fledged electrical engineers in the term of a year or so, especially if the lad appears to have some aptitude for "electricity." This aptitude is generally gauged by his fondness for electrical playthings such as frictional machines, Leyden jars, Geissler tubes, induction coils, and so forth. Given a youth who likes to dabble with these tricks, and a father who is absolutely ignorant of engineering science, there is little wonder if the latter considers the former a veritable EDISON in a potential state, and agrees cheerfully to his taking up "electricity" as the proper and most promising line of study.

To such a father not less than to such a son we would strongly recommend the presidential address delivered by Prof. JOHN PERRY before the Junior Engineering Society on the 11th inst. Prof. PERRY was a mechanical engineer long before he became an electrician, and he spoke to an audience the members of which were not in doubt as to what profession each should choose, but had for the most part already made their selection of the particular branch of engineering each intended to follow. Yet his remarks deserve attention from those who have yet to make the choice, and if his advice is acted upon it will save a good deal of disappointment and generally raise the status and prospects of electrical engineers. This advice is briefly the following:—Let none aspire to become electrical engineers who have not first been trained for mechanical engineers. Not only is such training necessary to enable the electrician to design his machinery with due regard to the strength of materials and other matters generally dealt with by the mechanical engineer, and as important in a dynamo or arc lamp as in a bridge or a steam-engine, but without a correct conception of mechanical forces it is utterly impossible for anyone to appreciate the character of electric and magnetic phenomena. It is only when we are able to definitely estimate and express in some measure the forces of Nature that we can speak of them in a scientific sense—until we can measure these forces, we know nothing about them. It is true we may perform tricks in which these forces come into play; we can charge Leyden jars and give some persons a shock, or we can experiment upon them with a "medical" induction coil, but such experiments will not teach us how to build condensers and dynamos.

In the address we have referred to, Prof. PERRY dates the beginning of the period at which the mechanical engineer applied himself to electrical machinery from about 1878, and gives as the immediate cause the discovery of electric transmission of power. The date is wrong, though we quite agree with Prof. PERRY that prior to 1878 mechanical engineers had not paid any attention to the construction of dynamos. We would even go further, and say that it was only after the Paris Electrical Exhibition in 1881 that the mechanical engineers, and especially English mechanical engineers, began to ask themselves whether it would not be possible to make of that toy machine, then known as the wonderful "A" Gramme (in which the armature was a conglomeration of wood, iron wire, cotton-covered copper wire and tape, the whole held together more or less by glue and friction), a sound mechanical job. In our opinion, the advent of electrical engineering in the present sense dates from that period, but the discovery of electric power transmission dates back to 1873, and took place at the Vienna International Exhibition, whether by sheer accident or not is a disputed point. If we consider that so valuable an application of dynamo machines was already known sixteen years ago, and has only been developed during the last few years, we must come to the conclusion that mechanical engineers have missed their opportunity for a very long time. The transmission of power is a subject which appeals far more directly to the mechanical engineer than the production of the electric light, yet it has been left to the electricians who wanted to use the dynamo for lighting purposes to improve it so that it may serve their purpose. Had the mechanical engineers been able to appreciate the dynamo when it first came before the world this improvement would have taken place some eight or ten years sooner, and we should all be the better for it. If Prof. PERRY'S advice be followed by those he addressed on Friday last there is no danger that a promising field will be similarly neglected in future. He counselled every mechanical engineer to make himself acquainted with at least the rudiments of electrical engineering, pointing out that the application of dynamos and other forms of electrical machinery must be for ever increasing, and thus create a greater and yet greater demand upon the skill of the mechanical engineer. On the other hand, Prof. PERRY advises electricians to learn drawing, in order that they may be able to put their ideas on paper in such a way that a mechanical engineer may carry them out without having to re-design every part. It would thus appear that Prof. PERRY makes a distinction between electricians and electrical engineers. If we understand him rightly, he would have every electrical engineer capable of designing mechanical work, every electrician capable of making at least an intelligible drawing, and every mechanical engineer cognisant of Ohm's law and other elementary matters connected with electrical science. When once the profession is thus subdivided we might indeed expect great things, even, perhaps, the realisation of Prof. PERRY'S plan of obtaining motive-power by a combination of heat battery and electromotor, to which he referred at the close of his address. He had pointed out in 1881 that if a voltaic cell could be made in which coal is burnt instead of zinc, and the current utilised in driving an electromotor, 90 per cent. of the heat energy contained in the coal could be obtained in the shape of work instead of only 10 per cent. as now with a boiler and steam-engine. The difficulties were, however, the great size and cost of the apparatus required. Now, Prof. PERRY told his hearers that the difficulty of excessive size of apparatus had already been overcome. He and his partner (whose name, however, did not transpire) now see their way to develop one horse-power per cubic foot of apparatus. We hope that Prof. PERRY will ere long take the engineering profession into his confidence and tell them how this marvellous result is achieved. The question of expense, which still seems to stand in the way, might then possibly also be solved by the united efforts of the three sections of engineers which, according to his plan, should form the profession.

ON MECHANICAL ENGINEERING IN ELECTRICAL INDUSTRIES.*

BY PROF. JOHN PERRY, D.SC., F.R.S.

This Society expects from its President for the year an inaugural address, with whose subject matter he is supposed to have a special kind of acquaintance, and which is of importance to the Society.

As a mechanical engineer whose apprenticeship began twenty-five years ago, and who has paid a considerable amount of attention to electrical matters, I feel that I have a sort of experience which warrants my speaking to you on the subject which I have chosen for this address.

Unfortunately, however, I find, like others in such a position as this, that a man who is busily engaged not only in teaching, but also in active practice in the engineering profession, finds very little time for putting forward his notions with either the literary finish or the completeness of treatment which his subject deserves.

Until a few years ago the construction of electrical instruments and machines and their erection and use were altogether in the hands of electricians who knew little about electricity, and who knew almost nothing of mechanical engineering. At present the best

* Presidential address to the Junior Engineering Society, Oct. 11, 1889.

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dynamos are made by experienced mechanical engineers who have somehow picked up a working knowledge of electricity, and for the last ten years I have tried to impress upon young electricians the necessity which exists for their learning how to make working drawings, and to make mechanical calculations, as well as for their being trained in the shops to use the hammer and chisel, and to learn the use of machine tools; in fact, that they must become good mechanical engineers as well as electricians. The electrical industries are more and more demanding the experience of the mechanical engineer. It is true that among the rank and file, for every hundred stokers, engine-drivers, fitters, and machine-shop hands employed there will always be need for perhaps ten men who may be called electrical plumbers; but I am not now thinking of the rank and file.

In 1860 it was almost unknown, and in 1870 it was very little known, that exact calculations might be made concerning electric phenomena: that is, that there was a science of electricity as distinguished from a mere natural history.

There were, indeed, publications in which the speculations of Franklin and other writers of from seventy to one hundred years ago on the nature of electricity, were fully entered into. Careful descriptions were given of rubbed glass-plate machines, of batteries of Leyden jars, the giving of shocks, the production of scenic effects by electric sparks, and the use of glass-legged stools. In general, such information was given as might be found useful by practical jokers. The information on Magnetism was of much the same childish order. The department of Voltaic Electricity, or Galvanism, as it was called, consisted of descriptions of various forms of voltaic cells, and of methods of joining cells together, so as to produce a maximum current in a circuit, with perhaps a description of the single-needle telegraph. The book was usually redeemed from worthlessness by some account being given of Faraday's experiments; but readers found that the main outcome of Faraday's work was the Ruhmkorff induction coil, whose most important function was to illuminate Geissler's tubes for children's parties. In fact, it may be said that up to 1870 the writers of books, and nearly all the teachers of electricity at schools and colleges, remained in a state of ignorance of everything except what may be called a list of electric tricks.

And yet the science of Electricity as we know it now had really been developed. The researches of Cavendish and Faraday and Joule were known to a few, and Sir William Thomson's magnificent series of Papers had been buried in journals and learned Society Transactions for, some of them, more than twenty years.

Now what distinguishes the engineer is this: he can design a thing which he knows will work if it is constructed exactly to his design. He makes exact calculations; but to do this he must have a quantitative knowledge of the phenomena he deals with. And the origin of Thomson's work, the origin of an exact knowledge of electrical phenomena, was this: Thomson was an engineer, he was engaged in practical telegraphic work of such a kind as necessitated his knowing quantitatively about the phenomena he was dealing with, and, like an engineer, he proceeded to acquire the necessary information; whereas the ordinary telegraph operator, the *quasi*-scientific experimenter and teacher, the popular lecturer, knew nothing of the fact that electricity can be measured. We cannot imagine a mechanical engineer regarding a few inches as being equal to a distance of some miles, or even of some thousands of miles, or his assuming that steel and brick are equally strong. We cannot imagine a grocer to confound an ounce of sugar with a ship's load of the same material; and yet these absurd notions give but too truthful an idea of the vagueness, of the general want of definiteness, which, till a few years ago, existed in the minds of nearly all men who called themselves practical electricians.

Observe that I am not contemning the labours of experimenters who did not have quantitative knowledge. In fact, the result of the work of such experimenters has very often been that an interesting problem has been put before the mathematical physicist, and it is sometimes forgotten that it is almost never the solver of a difficult problem, but really the setter of the problem, who is an inventor. I can throw ridicule upon the contrivances that I and many others have made in the past, but I know that the failure and partial success of such contrivances has taught us and the world how important it is to have an exact knowledge of the phenomena we deal with.

Such an exact knowledge of electricity is now readily obtainable, and it is well to consider how it was that this new engineering science was created with so much rapidity that in the last ten years a greater advance in its practical applications has been made than ever before in the history of the world.

Between 1860 and 1880, greatly in consequence of the work done by the Science and Art Department in this country, and its reflex action in other countries, some knowledge of the principles of electricity, which until then had only been known to a few people, became the property of thousands of mechanics, and it may almost be said that the rate of progress of electrical discovery became proportional to the number of people who had a little electrical knowledge. For example, what was wanted for the proper working of an arc electric light became known to many people, and in a short time hundreds of interesting methods of regulation were in use. The small magneto-electric machine, a toy for giving shocks and adding to the incomes of certain medical men, led to the machine of Wilde in 1866, which had electro-magnets. In that year Varley, who was Thomson's partner, and others, made independently one of the grandest discoveries of the century, and presently a machine was in use which excited its own field-magnets, the type of all dynamos ever since. With this principle of Varley's, and using the form of armature employed by Pacinotti in 1860, Gramme invented, some time later than 1871, his famous dynamo which first revealed to the world how large might be the output of electrical power from a small machine. All the time from 1866 to 1883 there was an ever-increasing number of mechanics contriving and trying their inventions, and demanding a clearer knowledge of electricity, and at length some of the few who had the knowledge put their knowledge in simple language before the world. The result was that in 1883 we had not only the Gramme and Alteneck or Siemens and Brush machines, but hundreds of others, which differed from one another mainly in mechanical construction. Even at this time there was no quantitative knowledge available concerning the magnetic circuit of the dynamo; but about five years ago Dr. Hopkinson, a well-known Whitworth scholar, discovered its law in seeking to improve that form of the Alteneck dynamo called the Edison, and showed that it was possible to have twice the output from a machine of given weight with a superior efficiency, so that now the simple laws not merely of the electric but of the magnetic circuit of a dynamo can be readily understood by any engineer, and in consequence the construction of dynamos and motors and other electrical contrivances is rapidly becoming as perfect as the construction of the modern steam-engine.

Let us give all honour to the experimenters who try all sorts of apparatus, some of them to be afterwards condemned as absurd, till they produce the germ of a useful invention; to the scientific men who use their mathematics and measuring instruments and give us exact laws. But we are not detracting from the honour due to these men when we also give credit to the mechanical engineers, without whom an invention would remain merely an interesting yet badly-constructed toy.

What particularly attracted the attention of the mechanical engineer to the new science from 1878 to 1883 was the fact that by means of a dynamo, A, driven by a steam-engine or water-wheel, and another dynamo, B, called a motor, and connecting wires between them, mechanical power in large quantities might be developed by B with very little loss in transit; that there might be many motors, B, worked from one or many dynamos, A; that the motors might work printing presses, or machine tools, or pumps and fans in mines and tunnels and other places to which communication of any other kind than by simple wires was almost impossible, or any other fixed machinery, or, again, railway carriages or tram-cars, or telpher trains in motion; and that electricity, the agent here employed, is not only capable of transmitting thousands of horse-power to immense distances with great economy, but it is an agent by means of which it is natural and easy to transmit signals and perform functions of a most complicated character at great distances, and so lends itself to most curious kinds of automatic working. They learnt also from Lane-Fox and Swan that the energy sent out by the same dynamo, A, could not only be used with accumulators, but be utilised in giving a most beautiful light, distributed in any required way, and they knew that the greater part of the work to be done in this new industry was purely and simply mechanical engineering.

The mere fact that dynamos could convert several horse-power was in itself enough to produce a revolution in one's regard for electrical matters. Hitherto we had looked upon telegraphy as a beautiful adjunct to railway and other kinds of engineering; but the power required to operate the telegraphic apparatus at Valencia is one one-millionth of a horse-power, and really, the transmission of this power from America, accompanied as it was by a waste on the road of something like 99 per cent. of the total power sent in at America, could hardly be regarded as having any connection with mechanical engineering. Hitherto the mechanical engineer had concerned himself with the machinery required to draw iron and copper wires, to cover wires with silk or cotton, gutta-percha or india-rubber; with cable ships and their steam-engines and propelling apparatus, and with the specially contrived machines for paying out cable and picking it up. In a thousand ways the electrical industries required the help of mechanical engineering, but in the very same sort of ways so did the ladies' dressmaking industries. The new discovery really amounted to the discovery of a new department of mechanical engineering, for it soon became evident that the dynamo A was analogous with a force-pump for water, and the motor B with a water-pressure engine, and the wires represented the communicating pipes in a system of hydraulic transmission of power, and that just as in the hydraulic system we could reduce the

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loss in transmission either by increasing the diameter of the pipes or by increasing the pressure, so in the electric system we could reduce the loss either by increasing the size of the conducting wires or by increasing the electric pressure.

Of course, it was at once seen that as dynamos must be driven, steam-engines and boilers must be put up, and the belt, or rope, or friction gearing, or direct coupling employed in driving, could differ very little from what are employed in driving fans, pumps, and other machinery. In arranging a central station there would be electric plumbing to be done, and some person must have a working knowledge of Ohm's law, which is a law easily understood by the hydraulic engineer. Given a little motor which you can cause to revolve in either direction by setting a handle on a tram-car, it does not seem to be a troublesome thing to arrange a method of driving the car from the motor; nor is it troublesome to drive an electric launch from a motor worked by accumulators.

And yet in the early days, what high salaries we had to pay for the minimum of knowledge of electric plumbing, combined with nearly the minimum of mechanical engineering knowledge! How much trouble we had over the gearing connecting an electric motor and the wheels of a tramcar! Well, those expensive days are over—the days of advertisement and Stock Exchange success, of making bricks without straw. Various educational institutions have now given us the straw, and, as a matter of fact, we see that the best man to take charge of a system of distributing light and power is an experienced mechanical engineer who possesses a good working knowledge of the simple laws which govern electric distribution in wires. Of course, this is on the assumption that the engineer has not to construct his own dynamos and lamps, and switches and wires and motors, and accumulators and transformers. Just one year ago I impressed this on an experienced engineer who knew almost nothing about electricity. He now knows how to apply Ohm's law in all necessary ways in the large scheme which he is carrying out, and he has a better practical knowledge of electric distribution and of all the calculations to be made than any of the electricians in his employment.

When I say that the mechanical engineer ought to learn Ohm's law, I mean that he ought to pass through a proper laboratory course, and make numerical calculations in which he will illustrate all sorts of ways in which this simple-looking law is applicable. A knowledge of what is meant by amperes, volts, ohms, and watts, cannot be obtained merely by listening to lectures or by reading. Just as a little use of a watch, of a two-foot rule, and of a spring-balance give exact practical notions of the measurement of time, of distance, and of force, so the use of an ammeter and voltmeter will give exact practical notions about Ohm's law and electric measurements generally.

And now as to the construction and manufacture of electrical appliances. Given perfect working drawings of any machine or instrument, with necessary instructions, the manufacture may be carried on by the ordinary foremen and workmen of any engineering shop. If I can be sure that my instructions shall be carefully carried out, I prefer to have my work done at such a shop. Only if something is specified as charcoal iron it must not be made of Siemens steel, as, I am sorry to say, it very often is, or of malleable cast iron, as it sometimes is. If plates are shown separated by Willesden paper, then Willesden paper, and no other material, must be used. As workmen obtain more electrical information, and therefore understand better why such instructions are given, there will be more certainty of their being attended to. This manufacture may really be said to be altogether in the hands of the mechanical engineer, and if he would only try to gain what is easily gained—a working knowledge of electricity and magnetism—the design of electrical contrivances would also be in his hands; for even now many electricians are not sufficiently alive to the importance of drawing. One gentleman I know, who has designed many successful instruments and machines, followed this procedure:—He went to his instrument-maker and gave careful instructions, illustrated by sketches, as to the making of a new instrument. At the end of a fortnight he went to see the instrument as made, pointed out that it was not at all what he wanted, and gave better instructions for a second—for, indeed, his own ideas were now clearer; went again and recommended changes to be made, and again and again, sometimes seven visits, with seven radical changes, taking place before the instrument was satisfactory. It required ocular demonstration to convince him that one could have every detail exactly as one wanted it in the first instrument made to a working drawing.

I am sorry to say that I have found it impossible yet to depend upon the good mechanical draughtsman to design new electrical appliances. You may explain to him most carefully what you want, and look over his drawing half-a-dozen times, but wrong details are sure to escape your notice, and his own knowledge of electrical matters is as yet very poor. The man who designs a new electric appliance must be a good mechanical engineer, which assumes that he is himself a good draughtsman; and he must also be a good electrician, and it only leads to fitting and trying and partial failures for two men with the two qualifications to work together, each trying to supply the deficiencies of the other. The reasons for this may become more evident if I consider with you the design of some one electrical contrivance, and nothing is better for our purpose than a dynamo.

A dynamo consists of an armature wound with insulated wire, revolving in the field of a fixed electro-magnet. [The action of a dynamo was here briefly described by the help of a diagram.] You will observe that when matter of any kind moves in a magnetic field, there is an electromotive force set up, tending to produce an electric current, and to convert mechanical into electric energy. If the matter is conducting, like copper and other metals, the currents circulate locally in the conductor, the electric energy being wasted as heat. But when we know the exact laws of the phenomena, we can arrange that the currents shall be sent through metallic circuits outside the machine and utilised. If a disc of copper revolves so that the magnetic flux is sometimes at right angles to and sometimes parallel to its face, there will be a great resistance to its motion and a great waste of power, because of local or "Foucault" currents, whereas, if it revolves so that it is always edge on to the flux, there is but little waste of power. [The general arrangement of the fixed part of the machine was described, and it was incidentally mentioned that the iron parts when in a state of strain are less magnetic.] Now, the distribution of the fixed and movable iron is what Dr. Hopkinson has given us exact simple information about, and the sizes of the iron parts must be settled first. But the magnetic laws, although easily stated, cannot be understood by the designer and instinctively applied, all so simple as they seem, without a considerable amount of study and numerical calculation I will not here enter into them, but it may be mentioned that although it seems very easy, it is really not very easy to get into the way of using the centimetre (about two-fifths of an inch) as the unit of length. I have tried in various ways to avoid using this unit, but I am sorry to say that in these calculations all measurements must be taken in centimetres, and the dynamo designer must get used to thinking of distances, not in inches, but in centimetres. There is no doubt that this is a great affliction, for he still uses the inch as his unit of measurement when making calculations of strength and stiffness.

What comes very easy to the engineer is the notion of and the measurement of the efficiency of a dynamo. It is not unusual for manufacturers to distinguish between the electrical efficiency and the commercial efficiency of a dynamo. However useful the term "electrical" efficiency may be to those whose object it is to sell machines, to the engineer "the efficiency" is the useful output of electrical power divided by the mechanical power actually given to the machine.

Power is wasted in the machine, 1st, at the journals and brushes in mechanical friction; 2nd, in air friction; 3rd, in what may be called magnetic friction, and unless care is taken in properly dividing and insulating the iron and other metal of the armature to prevent induced currents circulating in it, this metal, and sometimes the metal of the fixed magnet at its pole pieces, gets greatly heated; 4th, in electric friction in the wires of the armature, because electric currents flow through them. It is, indeed, this loss of energy, or rather, the rise of temperature produced, which determines the output possible from a given size of machine; 5th, a loss due to the reversal of current continually going on in the coils of the armature as they pass the brushes. You see that I have separated these losses, and each can be measured separately; but my ability to separate them, however interesting and useful it may be, gives me no right to leave out any one of them in stating the efficiency of the machine.

Some two years ago my kind friend the editor of *The Electrician* had two beautiful wood-blocks prepared to illustrate a course of lectures of mine. It seems very easy to edit one's lectures after they have been carefully prepared; but I am sorry to say that time has not allowed me yet to fulfil my engagement. However, I will circulate among you some proofs from these blocks. In one you see how we test a motor, in the other how we test a dynamo, and without actually making such tests for yourselves, I hardly see how you can gain the exact working knowledge which the engineer ought to be possessed of. The figures shown are carefully drawn from Prof. Ayrton's arrangements at the City and Guilds Central Institution, although my students experimented with the less elaborate apparatus at Finsbury. The apparatus is always ready for use. In Fig. 1, L is a Raffard (or James Thomson or Carpentier) absorption or consuming dynamometer, whose spindle is connected with the spindle of the motor M by means of a flexible coupling. The difference between the weights in pounds, multiplied by the velocity of rubbing between the cotton belt and the pulley (that is, the circumferential velocity of the pulley) in feet per minute, divided by 33,000, is the horse-power which is being absorbed in friction. Soapy water is kept trickling from the reservoir T on the rubbing belt. With this dynamometer, or with the simpler one for small powers designed

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by Prof. Ayrton and myself, the motor can be kept running for hours at the same speed, and giving out the same power all the time. An ammeter and voltmeter measure the electric power given to the motor, and there is a squeezable carbon-plate resistance in a box to vary this power.

In Fig. 2 you will observe the wonderful double-cone method of continuously varying the speed of the dynamo being tested which Prof. Ayrton persisted in employing, although I told him that it could not work, as his belts were certain to break. He was right, however, and I was wrong. Observe that the dynamo is driven through a Siemens' Dynamometer, which measures the mechanical power given to the machine ; and, of course, the electrical power given out by the machine is measured with electrical instruments.

You see, then, that in electrical transmission of power we can measure with great exactness the efficiencies of the dynamo and motor. An easy measurement, or, indeed, in most cases, an easy calculation of the resistance of the conductors between two places, enables us to make exact calculations as to the loss in transmission. In fact, a distinguishing characteristic of electric work, something which is rather absent from hydraulic work and other methods of transmitting power, is the accuracy and ease with which we can make such calculations.

You will think, perhaps, that I am dwelling too long on this matter, so I will not say anything about the way in which we can divide the total loss in either of these machines so as to get exactly the five portions referred to above. Those who are interested may refer to a Paper on "Electro-Motors" published in the *Journal* of the Society of Telegraph Engineers about seven years ago.

The Mechanical Engineer may safely be left to the problem "What is the best length and shape of the journals of a Dynamo?" Even in this, however, he will find special conditions presented to him. For example, the rotating part of a dynamo is always, or may always be made to be, well balanced. The speed is usually high, so that gyrostatic action on board ship must not be altogether neglected. Sometimes the dynamo is driven direct, and if a flexible coupling be not employed considerable pressure may be produced at the bearings ; or it may be driven by belting to its overhung pulley, and again we have to consider the pressures.

Two years ago I had careful measurements made of the diameters, lengths, and speeds of the journals of all the dynamos and motors belonging to a certain educational institute. There were twelve altogether, and they were all from well-known electrical engineers. At that time I said that large dynamos of the future would have

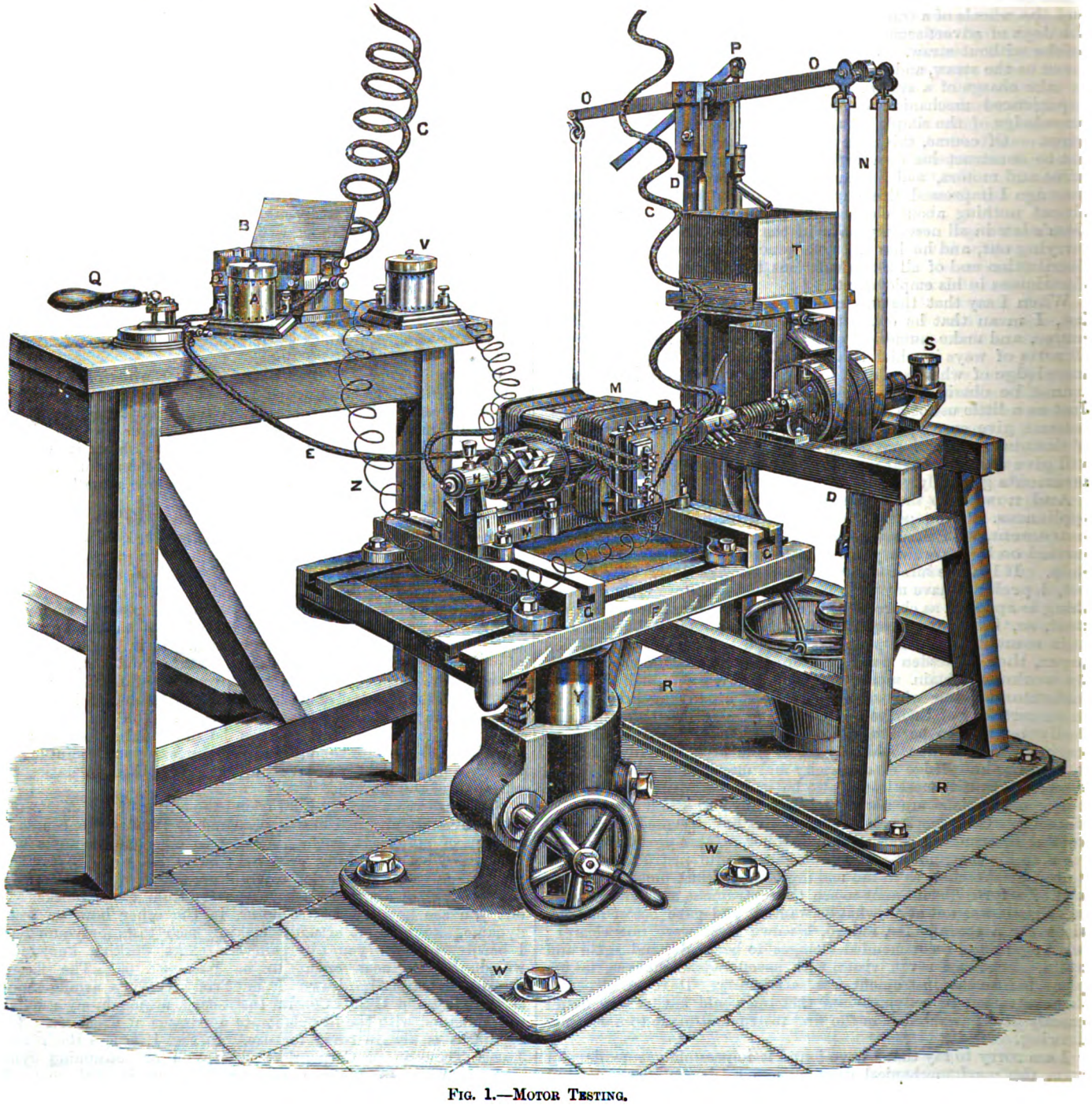

FIG. 1.—MOTOR TESTING.

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roller bearings, but hitherto my prophecy has not been fulfilled. Well, I was unable to find any law connecting the dimensions and speeds and weights, not merely of the whole twelve, but even of any group of them, until I took into account a possible want of balance and spring of the spindle under centrifugal force, and then I was able to find a rule.* [*See* foot note on next page.]

It then struck me that possibly the well-known rule for ratio of length to diameter of journals in ordinary shafting, which has been found to work so well, and yet for which we have hitherto seen no reason, is really explainable on considerations of possible centrifugal force.

Then as to oiling, we have not merely to think of the necessity

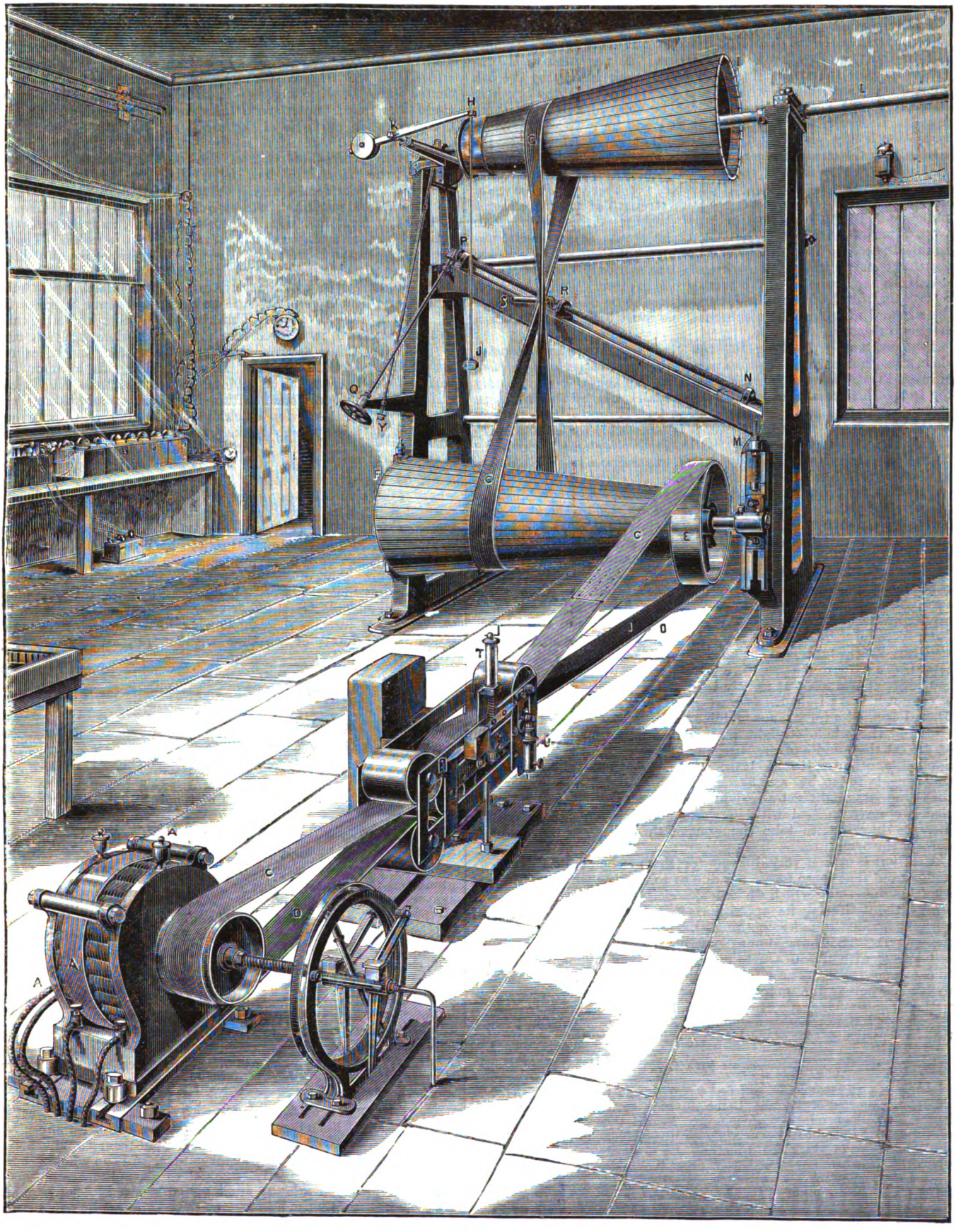

FIG. 2.—DYNAMO TESTING.

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for a regular supply of oil, but of preventing this oil from penetrating the neighbouring commutator. A very little oil on the commutator surface is not objectionable, but in certain places, where there are short spaces of surface insulation, if a spark once passes through oil it may leave a carbonised residue, which destroys the electric insulation.

It is important that the dynamo should be efficient, but it is even more important that it should be *durable*. It is true that efficiency and durability go together to some extent. For example, it is difficult to imagine that a machine shall waste much energy by the 5th cause already mentioned, which leads to sparking at the brushes, or by friction at the bearings, and yet be very durable. In some respects, however, they are antagonistic ; and here we see why two men—one solely mechanical and the other solely electrical—are unable to assist one another much, and that one man must combine in himself the necessary mechanical and electrical knowledge. Everything must be as strong as possible, yet there must be good electric insulation everywhere. Again, strength of armature seems antagonistic to the necessity for great division of the iron so as to avoid Foucault currents. The electrician wants as great circumferential speed as possible in the armature, but the mechanic points out that considerations of centrifugal force will only allow of higher speeds, as the diameter of the armature is greater. The electrician retorts that for drum or cylinder armatures to be of large diameter the size and weight of the whole machine must be great, for certain magnetic reasons.

It is not merely in designing the general shape of a dynamo, then, that the engineer requires a working knowledge of the laws of magnetism, but even in such details as the method of dividing the iron of his armature so that no loss shall occur by the 3rd cause given above—that is, by Foucault currents. He must have such an acquaintance with the subject that it is impossible for him to make a mistake without experiencing that instinctive repugnance for what he has done which a good draughtsman experiences in such matters as fillets in castings and bolts and nuts.

It is difficult for us to understand why young Watt wondered at the possible pressure of steam on the lid of the mythical kettle. Yet there are many millwrights now existing who cannot comprehend the pressure of steam inside a vessel. It is in no respect more wonderful than the force which resists the motion of a wire through the magnetic field of a dynamo. Here, for example, is the copper wire of the armature of a certain dynamo. When the armature is revolving, and the proper current is flowing, there is a total force on this piece of wire, resisting its motion, of 8lb., and the centrifugal force on it is 24lb.† I remember once taking a wire of this size (2ft. long) and putting it on a piece of board shaped like the internal core part of the armature of a machine, fastening it round the edges of the wood as tightly as it is in the ordinary machine. It cannot be very tight because we must not hurt the insulation. Then I applied a force—not of 8lb., because that would be spread all over the whole straight piece of wire 2ft. long, but a force of 4lb. at the middle of the wire, pulling it sideways, and then I applied another force of 12lb. at the middle to represent the centrifugal force by another cord and weight and pulley, so that students might get a real idea of the magnitude of the forces that we have to deal with in these machines—forces trying to displace the wires, to take them out of their present position and deform the armature.

Really it is at first very difficult for the mechanical engineer to understand that these forces are due to something which he cannot see (this something which we call electricity) passing through the wire without altering its appearance in any way, and because that wire is moving through something which again he cannot see (a magnetic field). That force, due to invisible things, you will have to get acquainted with if you are to understand about dynamos and how to construct them. These forces resist the motion of the wire in a dynamo, whereas in a motor they produce the motion.

This resisting force is applied, then ceases, is applied and again ceases ; that is, it is twice applied and twice destroyed in every revolution. The average resisting force on the above wire during a revolution is only about 3lb. If you carefully study these figures you will understand why it is that the construction of an armature has become a part of mechanical engineering. Ten years ago dynamos were not very powerful, and the resisting or driving force on each piece of wire was not very great, so that the friction between insulated wire and the iron core on which it was coiled, and again, the friction between this wound core and a wooden centre which acted as a wedge in attaching the core to the spindle, could be relied upon with certainty. In modern machines, however, such methods of fastening would be childish to think of. But, difficult as it is at first to think of these resisting and driving forces on bits of wire moving through the atmosphere, the mechanic has more difficulty in comprehending how great these forces may suddenly become in an accidentally short-circuited machine. All at once the wires have, perhaps, ten or twenty times their usual greatest currents, and their motion is resisted by forces ten or twenty times as great as usual. They had been going through the atmosphere for days or weeks at a regular rate, their currents were just great enough to keep them safely warm, when suddenly ten to twenty times as much resistance to motion occurs, and heat is generated at one hundred to four hundred times as great a rate in them. Unfortunately some dynamo makers will not believe in figures like these, and when they are unable to make any other answer, they assert that their machines never are short-circuited. I assert, however, that this accident often happens, and that it is seldom that a machine has been in existence for a long time without a short circuit taking place. Happily in direct-driven machines the engine is usually pulled up—that is, the dynamo brakes the engine—and in belt-driven machines the belts slip ; but enormously increased stresses do occur for a short time, and the possibility of their occurrence must be taken into account. If this is important in dynamos, where excessive stresses occur only accidentally, think how important it must be in motors, where it may often happen that the full electric pressure is turned on even when the machine is at rest or moving slowly. I remember that, when putting up a telpher line about four years ago, I became quite desperate on account of the failure of one kind of motor after another, until at length I used the Immisch motor, which was designed by a man who combined mechanical and electrical experience. These motors have worked for years now in the charge of Sussex labourers, more or less exposed to all kinds of weather without renewal. Now, if you

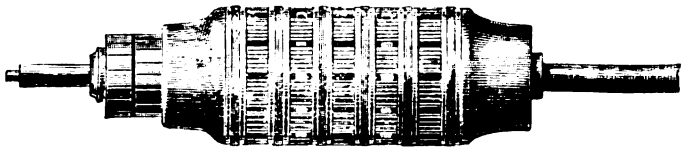

Fig. 3.—Armature of Immisch Motor

examine the armature of the Immisch motor (Fig. 3), you will see that the wires are bound down, almost covered, in fact, with many bands of phosphor-bronze wire, and that they are wound among numerous projections of iron to give the necessary strength. You can observe in the specimen I show how strong-looking these projections are. In this armature of 3in. diameter there are four iron driving discs, with altogether about forty-eight projections, each being a cube of nearly $\frac{1}{4}$in. edge. I am told by the maker that on one occasion in early days, when cast iron was used, every one of those forty-eight projections was suddenly stripped off in the natural working of a machine. Remember that the wires were bound down tightly almost the whole length of the motor with bands of fine phosphor-bronze wire, well soldered together here and there, so that the iron projections were not alone relied upon. I know of nothing which has more impressed me than this with the fact that the electrical industries require the experience of mechanical engineers.

Now, every one of these numerous copper wires is subjected to such forces as I have described, and yet no one wire must touch another metallically; they must be insulated from one another, and also from the iron core of the armature, and the whole armature must be strongly and rigidly attached to its spindle, and yet the fastenings must not take up much valuable space. I have also said that the iron core must be of numerous thin plates, which do not touch each other or the fastenings to the spindle metallically. Again, the armature must allow air to pass through it fairly well to keep the wires cool, and we must allow for local expansions and contractions by heat ; also the smaller the clearance between the revolving armature and the fixed magnet the greater is the output of the machine. [The construction of the Crompton armature was described with the help of a diagram.] I know of nothing

* Making certain probable assumptions as to want of balance, I found that for a particular type of machine

$$\overline{d} = a + b\,n\,\sqrt{L}$$

ought to be approximately satisfied in well-made machines, where l is length, d diameter of journal, L the distance between the journals in inches, and n the revolutions per minute. In the then state of dynamo construction I thought it worth while to divide dynamos into two classes only—1st, those in which the armature was drum-shaped ; 2nd, those in which the armature was disc-shaped. For the first class I found that $a=2$, $b=\frac{3}{1000}$, and for the second class $a=0$, $b=\frac{1}{1000}$, gave rules which satisfied the dimensions of the twelve machines.

† If a wire has 234 amperes passing through it and moves in the usual field of a dynamo (for those who may care to check my figures I may say that I take $\beta=7500$ C.-G.-S. units as the maximum field) we may take it that a force equal to the weight of 1lb. acts upon it per inch of its length. The force is proportional to the current and does not depend upon the velocity. Observe that it is better to calculate in this way than from the horse-power, because we want the greatest force—that is, when the wire is in the most intense field.

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which requires a more general exact knowledge of the mechanical, electrical and other properties of materials, and the strength and stiffness of structures which may be subjected to local heating, than the design of the armature of a dynamo. Why, even the seventy-two fastenings of the wires to the seventy-two pieces of the commutator have been the source of much trouble, for these fastening pieces are themselves passing through some magnetic fields, and what with the magnetic resistance to their motion and their centrifugal force, and a constant vibration to which they are subjected, their arrangement presents not one but numerous new problems to the mechanical engineer, and these problems are not yet satisfactorily solved.

To describe the design of a dynamo more in detail would only weary you, so I will finish this part of my subject by referring to the commutator. Here is a nearly cylindric body. It is built up of seventy-two separate pieces, all separated from one another by thin pieces of insulating material. Not only must there be no metallic contact between piece and piece, but between any piece and the spindle to which the commutator is strongly and rigidly fastened. Now, no insulating material is very strong—it is apt to warp with heat; yet the whole structure must be strong and rigid. As it is rubbed on the outside by two metallic brushes, it is important to reduce friction by having it not too large. Some manufacturers have actually made such a commutator as this bear up against the step of the bearing, so that it should take an end-thrust, instead of putting a loose collar on the spindle. You must remember that these seventy-two pieces must all be rather deep, as they will be wearing away against their brushes for some years before they are to be renewed. Again, for the prevention of sparking the pieces ought to be of copper, but for wear, under the action of the rubbing brushes, the pieces ought to be of some material more approaching phosphor-bronze in character.

I need hardly say that the man who designs a dynamo machine ought to know something of how his design will be carried out in the shops. Again, his design will not be quite the same if only one machine is to be made as it would be if hundreds or thousands were to be made and the principle of interchangeableness of parts were to be applicable. For in this case, to take one detail, instead of casting a commutator piece of phosphor-bronze, or making experiments to find how little is the quantity of silver that one must add to copper so that a good casting of the piece may be possible, he would probably have a machine which would roll out the wedge-shaped commutator pieces in one long strip, and this would necessitate a change of design in the fastenings. His copper winding would be curiously flat in section. He would design the iron pieces of which his armature core is composed so that they might be stamped out, and he would alter his design so that the manufacturer could make large use of stamping and forging and milling machines, and in many other ways he would use his mechanical engineering knowledge for the purpose of facilitating manufacture.

You may, perhaps, think that I have dwelt too long upon my statement that an electrician must be a good mechanical engineer, or that applied electricity is merely a branch of mechanical engineering. Before Watt's time there were mechanical engineers, and when the new branch was annexed it was not called heat engineering, although all mechanical engineers were, after that period, expected to know with such exactness as was then possible the laws of heat.

Gentlemen, we are all specialists now; we devote ourselves to particular branches of our profession, but, all the time, each of us has a general knowledge of other branches of the profession. Each of you has some special knowledge, either of hydraulic machinery or stationary engines, or locomotive engines, or gas engines, or marine engines, or boiler making, or cranes and hoists, or machine tools, or some other branch of the profession. But if a man called himself a mechanical engineer who had not some general knowledge of all these branches, would you not look upon him with a certain amount of contempt? And you would be right, for the scientific principles of all the branches, and their application, and the special contrivances of all, enter often in most unexpected ways into one's own special work. The gist of this address is that the electrician has become a member of your profession. My own belief is that ten years hence he will be of as much importance in the profession as the steam-engine engineer, and that no man having a right to call himself an engineer will be without a good working knowledge of electricity; for this knowledge will give him a new weapon, which he can wield with unexampled certainty, and which, in my opinion, will develop into the most powerful weapon at his command. I could already give you many examples of the way in which a knowledge of electricity will enable you to develop your special branches of engineering, such as that of electric welding and the electric tempering of steel, and many others.

But I will end this address by asking you to put some faith in the following statement:—You know that the best steam engineers never expect to obtain more than one-tenth of the total energy of coal as actually given out by a steam engine, and that in some small engines only one one-hundredth is given out. The idea that we are wasting at an enormous rate the energy stored up for us in coal by nature during millions of years is one that sometimes becomes oppressively horrible. Now, I pointed out in 1881 that if coal or gas were burnt in a Voltaic cell as zinc is burnt, and an electro-motor were used, we could utilise as mechanical energy not merely one-tenth but nearly nine-tenths of the energy of coal. I pointed out then that coal gas could be burnt in this way, but there were two difficulties—1st, the apparatus required was too large per horse power developed; 2nd, the apparatus required was too expensive. The first of these difficulties has already been got over by a correspondent, who is in some sense my partner. We see our way to developing one useful horse-power per cubic foot of volume of apparatus. Unfortunately, the difficulty of expense still remains. But I am firmly convinced, and I have good reason for my belief, that all the difficulties will be got rid of, and that coal will actually be burnt in this way. Even to those of you who may not be troubled about the general question of economy, the mere possibility of an armour-clad being able to carry enough coal for a voyage at full speed round the world, must appear to be an important result. With the ideas of steamships carrying very much greater cargoes and going at greater speeds, and other ideas which must strike you all as the result of the above economy, I will leave you, but I must confess that the general question of economy and its influence on the progress of the race appeals to me with infinitely greater force.

ON THE PRESENT STATE OF TRACTION BY STORAGE BATTERIES.*

BY DR. LOUIS BELL.

The possibility of profitably employing storage batteries for electric traction has been a most alluring one, and during the last ten years experiments have been continually in progress toward that end. Most of these experiments have been, for obvious reasons, private, and but few definite results have ever reached the public. Reports, indeed, have been tolerably numerous of late, but in most cases all details that could possibly give a basis for an estimate of the value of the system have been omitted. Everyone now knows that a car can be propelled at a good rate of speed and up reasonable grades by means of a storage battery, but the questions to be answered are: What is the first cost and probable yearly depreciation of the batteries? What is the efficiency of the system? What is the probable cost of operation compared with horses, cables and other electrical systems?

These questions, perhaps, cannot now be fairly answered, but some recent publications give data far more valuable than anything previous; and a discussion of the general state of the problem at present is not untimely.

First, as to the efficiency of the system. It is clear from the start that the double transformation involved in the storage battery must involve a more or less serious loss of energy. The amount of this loss is easily measured in a given case; but, unfortunately, it is far from being a constant. On the contrary, it is an exasperatingly variable function of the charge and discharge rates and other minor factors. The main losses in a storage battery are due to heating, local action and electrolysis of solution, and these can never be eliminated and may be greatly increased by improper treatment of the cells.

Tested in the laboratory, at low charge and discharge rates, an efficiency of 85 to 90 per cent. is quite obtainable from most modern types of cell. But a heavy discharge rate greatly lowers the efficiency, and not only does this, but is very liable to injure the cell permanently. The same cell which gave 90 per cent. efficiency at a low discharge rate may give but 50 or 60 per cent. when discharged rapidly. There are no data available to show the efficiency of a storage battery under anywhere nearly the same conditions that exist in electric traction.

The experiments which have been made with rather heavy discharge rates seem to point to from 60 to 70 per cent. as the greatest efficiency that can be expected. But these experiments do not represent the case. In street car practice the discharge rate must be of the most variable kind, and the efficiency of a storage battery under a widely varying discharge rate has never to my knowledge been determined. It would not be sufficient to determine the amount of variation and then deduce a result from experiments at a constant discharge rate, for the effect of a heavy discharge will vary as the battery is freshly charged or partially run down.

Experiments on this subject are greatly needed. As to the efficiency of the other portions of the electrical plant information is easy to obtain.

The engine used for charging the batteries can be used rather more economically than in the electrical systems using direct

* From the New York *Electrical World*, October 5th, 1889.

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supply, for it can be run, even if not under constant load, at least under one not subject to sudden and great variations.

The efficiency of the dynamo being the same in either case, and taking the friction of the engine at 10 per cent. of its rated full load, an estimate in accordance with good modern practice, the efficiency from steam to electricity at the charging station might be fairly taken at 75 per cent.

$$\frac{\text{E.H.P.}}{\text{I.H.P.}} = \cdot 75$$

The efficiency of the motors should be very nearly the same in either storage or direct systems, and for the motors in general use, the commercial efficiency, including friction of gearing, may, perhaps, be taken at 75 per cent., this figure being subject to so many varying conditions as to be rather uncertain.

Regarding the efficiency of the accumulators, I have shown that an accurate estimate cannot at present be made. At best it is very uncertain, but under the rather severe conditions imposed by traction work, I should much dislike to rely on a working efficiency greater than 70 per cent. from any accumulator with which I am acquainted.

We are now in a position to form a rough estimate of the probable efficiency of the storage battery system from indicated horse-power at the engine to wheel horse-power at the cars. Taking the above estimates, it will be:

$$\frac{\text{W.H.P.}}{\text{I.H.P.}} = \cdot 75 \times \cdot 75 \times \cdot 70 = 40 \text{ per cent. approximately.}$$

Comparing this figure with the direct supply systems, I find that Mr. G. W. Mansfield in his recent admirable Paper agrees substantially with my own estimate of the obtainable working efficiency in this case, placing it at a little under 50 per cent. for ordinary cases.

If this comparison seems unfair to the storage battery, I can only reply that I am a believer in the ultimate success of the accumulator, and would hail with joy any authentic tests disproving the above estimate.

But there is yet another side to the efficiency question that deserves careful attention. In the storage system extra power must be furnished to drag around the nearly two tons of battery. In other words, the proportion of the power furnished which goes to doing useful work is much diminished.

In fact, with any system of motors whatever, it becomes necessary, if an idea of its real efficiency is to be obtained, to take into account the effect of its dead weight on the amount of power to be furnished. There may often be good economy in sacrificing theoretical efficiency to gain practical efficiency.

To obtain a proper basis for the comparison of various motor systems we must, then, take into account the proportion of total to useful work, and to do this I have found it convenient to combine the theoretical efficiency with the ratio of useful to total work as follows:—

$$\text{Economic ratio} = \frac{\text{commercial efficiency} \times \text{useful weight}}{\text{Total weight}} = \frac{\text{E L}}{\text{W}},$$

writing E for the total commercial efficiency and L and W for the useful load and total weight respectively.

The above ratio gives a correct measure of the proportion of the power supplied to any motor system which is utilised in doing useful work. The reciprocal of the economic ratio will then be the amount of power that must be supplied to the system to do unit amount of useful work.

It measures the passenger-carrying power per horse-power furnished at the prime mover.

From the standpoint of the economic ratio it is possible to make a fair though necessarily approximate comparison between all sorts of motor systems, and to make this comparison on a common basis.

Now apply this, say, to the comparison between an ordinary electric car, a storage battery car, a cable car, and a locomotive. The total commercial efficiency should be taken as the ratio between the power generated at the prime mover and that exerted at the car wheel. The useful load should be taken in each case as the weight of the necessary car body and truck *plus* the weight of a full working load of passengers. It is clear that the car should be included, being a necessary load in each case.

Take first an ordinary electric car. A 16-foot Sprague car with two 7½ horse-power motors complete weighs about 6,400lb., of which about 2,400lb. is in motor apparatus and 4,000lb. in car. A full working load would be about 30 persons, estimated weight 4,000lb.

For a storage battery car I will take the figures of the new Julien car as far as possible. The car is stated to weigh complete 14,000lb., of which 3,800 is battery. The car has to be of unusual solidity, on account of the great weight of battery. It is a 16ft. car, and has the same carrying capacity as the above.

The cable cars are always run in trains, consisting of grip and motor cars, both carrying passengers; but as the weight of the grip apparatus is negligible, compared with the total weight, the system must be credited with an economic ratio equal to its efficiency, say, 50 per cent.

In the case of a locomotive we may take the weight of engine at 80,000lbs., tender (mean) 20,000lbs., and train of, say, four ordinary coaches, Pullman and baggage car, aggregating about 90 tons. The commercial efficiency of the system is high, since we have only to deduct engine friction, amounting to about 10 per cent. probably.

These weights are only approximations, and in any special case of course the actual weights would be substituted.

They will, however, lead to a tolerably fair comparison, and will enable some conclusions to be drawn as to the nature of the variations in the economic ratio in different systems. Computing then $\frac{\text{E L}}{\text{W}}$ we have:—

System.	Economic ratio $\frac{\text{E L}}{\text{W}}$	Power for unit useful work.
Direct electric	·385	2·62
Storage	·18	5·55
Cable	·50	2·00
Locomotive.....	·58	1·72

The economic ratio for the steam systems will increase decidedly with a heavier load, while for the electric roads it will increase, but more and more slowly as the electrical efficiency of the motors falls off. Where traffic justifies it, the use of a trailer is decidedly beneficial, evidently. The storage car seems needlessly heavy, and its economic ratio ought to be raised to ·25. The car used in Antwerp would have given an economic ratio of ·29, but it carried 1,200lb. less storage battery than the New York car.

From the inability of a storage battery to stand very heavy discharge rates, the weight of battery per horse-power hour stored is quite large. From the figures given by the Julien Company as to its New York cars, the battery has a capacity of 35 horse-power hours, and consequently weighs 108·6 pounds per horse-power hour.

It seems at present impracticable to run a car successfully and furnish the power necessary for the exigencies of the service with less than 3,000—4,000 pounds of battery. Unless the cells are very much lightened intrinsically or made capable of standing a much higher discharge rate than at present, there seems to be little hope of reducing this battery weight to a reasonable figure.

Next, as to the life that can be reasonably expected from the cells. All sorts of figures are given, but the only ones that seem to represent the real experience gained in the practical operation of a road are those recently published from the Brussels roads.* According to the result of two years' running, the positive plates would have to be renewed every 200 days. The life of the negative plates would be much longer. An American report on another type of battery used in train lighting reported positive plates destroyed within a year, and very similar experience seems to have been derived from nearly all storage batteries—out of the makers' hands. Of course with expert care continually exercised better results can be obtained. This short life makes the expenses of renewal considerable, and but little comfort can be derived from the recent suggestion that the car companies would do well to reconstruct the positive plates from the disintegrated material. From a practical point of view this is about as feasible as rewinding their burnt-out armatures and casting new trolley wheels out of the scraps of the old ones. No company of moderate size could profitably undertake this sort of work.

As to actual running expenses, the most complete figures are to be found in the Brussels report. The total expense for motive-power, repairs, renewals, &c., was 8 cents per car mile—$4.80 per car day, the run being 60 car miles.

The cost of maintaining the batteries proved to be 2¾ cents per car mile—$1.65 per car day.

The above cost of motive power was the same as with horses, while cost of plant, royalties and other expenses, brought the cost of operating with electricity considerably above that with horses. The cost of motive power, as estimated by the accumulator company was 6$\frac{4}{10}$ cents per car mile as the outside limit, while their estimate of maintenance of batteries was 1½ cents per car mile.

The estimates of the Julien Company, in New York, give motive power at $3.40 per car day of 75 miles. It is to be hoped that the ratio between estimate and fact is more favourable than on the other side of the Atlantic.

By comparison with the systems of direct supply, it is evident that, owing to lower efficiency, the expenses in actual power for the same service will be considerably (50 per cent. or so) larger in the storage system. That much is assured by the lower commercial efficiency and increased weight. Then we have maintenance of

* See *The Electrician*, August 16, p. 386.

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batteries and motors, estimated by the Julien Company at $700 per car per year, as against maintenance of lines and motors in the direct supply system. The low figure on this would certainly be far below the above figure, particularly on roads of any size.

The comparison of the storage system with horse traction is not so easy. The Brussels figures are decidedly in favour of horses after two years' thorough trial. The track on that line, however, is not good, and the grades are higher than seem advisable with the storage system, there being one grade of 4 per cent. 1,500ft. long. American figures are not sufficiently definite as to details, and the favourable results have been obtained by an accumulator company's own expert care. All that can fairly be said is that it yet remains to be proved that the storage system can be operated as cheaply as horses. So long as we have to rely on the heavy and rather perishable lead accumulator, proof will be hard to obtain.

It seems to have been demonstrated that the storage system, economy aside, may be made thoroughly reliable in careful hands. The New York cars have an enviable record in this respect.

To sum up: The storage system has certain great merits which especially commend it for city work. It requires only a track; each car is an independent unit, and no accident can cripple the system. The service can be made thoroughly reliable.

Its economy is at present doubtful; it costs distinctly more than traction by direct supply and probably more than traction by horses, unless under specially favourable circumstances.

In any electric system carefully laid track is necessary for success, but in the storage system it is doubly so, and steep grades are peculiarly undesirable. There is nothing more likely to hasten deterioration of batteries than the jolting due to a rough track and the heavy discharge rates necessary on a steep grade. For city work, with good level tracks, it is certainly an ideal method of traction.

In closing, let me say that I feel confident that the time will come when the storage battery will be the general method of traction wherever the overhead wires are objectionable, and specially in large cities. The time is not yet, however, and it is by no means certain that any of the present types of accumulator will share in the ultimate success of the system.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 5, 1889.

The month of October opens with a remarkable interest in various directions in the electric railway situation. The American Street-Railway Association holds its eighth regular annual meeting on the 16th, at Minneapolis, when the attendance will be large of representative street-railway men from all sections of the country. One of the chief subjects for discussion will be "The Conditions necessary to the Financial Success of Electricity as a Motive Power." This is highly important, for with all due consideration of the other advantages to be gained from the adoption of electricity on their roads, it behoves the owners of these properties to see to it that the financial results are such as will prove satisfactory. I do not think that electricity has anything to fear whatever from a most thorough discussion and ventilation of this particular topic. Of course, it has to be borne in mind that street-railway men are not likely at any time to advertise very freely figures showing just how economically they can operate their roads, because any striking exhibition of this kind would immediately invite an attack upon them in the nature of an attempt to reduce fares. In connection with this meeting there will, of course, be an exhibition of apparatus, and the result will probably be a further increase in the number of railroads. It is already understood that the Thomson-Houston Company have secured large contracts in St. Paul and Minneapolis, but I doubt whether the roads will be in operation by that time. It is interesting to note that in connection with this meeting of the national body will be held a Convention of the Western Electric Railway Association. Electric roads are going in at such a rate in the West that it has been deemed desirable and necessary to form an organisation of this character. It has already held one meeting, and it is expected that this second one will be very interesting and valuable. That such an Association should be formed, and that material should be found for it, exemplifies in a very vivid manner the rapidity of growth in this new electrical industry, which but a year or two ago had no standing whatever except on an experimental basis. It may be remembered that last year at the meeting of the Street-Railway Association one of the members rose in his place and objected very seriously to the discussion of electrical topics, on the ground that the members did not come there to learn anything about visionary and new-fangled methods of running their cars, but to ascertain chiefly the best way to feed horses, shoe them, dispose of their manure, and sell them when old. If that gentleman, who was so eloquent a year ago in favour of the methods of the good old times happens to attend the Convention a couple of weeks hence in Minneapolis, he may be apt to find most of the members joining the electric-railway ranks, and not enough left with himself to form an Association for the advocacy of the policy of sticking to horseflesh.

It is not to be supposed that all this phenomenal development of electric railroading takes place without drawbacks and difficulties innumerable. The wonder of it is that the industry has already gone as far as it has when we consider how grave are the obstacles that have to be overcome. The electric railway companies have to be financed, for their operations are heavy, and then, of course, they have to wait a little time between the receipt of a contract, the delivery of the goods, and the going into operation of the road. We have passed beyond the day when the street railways in this country expected to have their roads equipped for nothing, simply as a return for the advertising that they gave the system; but even now there are not wanting instances in which, for the sake of stock gambling or worse, it is sought to bring discredit upon one or other of the electrical systems.

While on the subject of electric railways, in case I have not wearied your readers, I would like to mention that a very interesting analysis of the present state of traction by storage batteries appears this week in one of the electrical papers here by Dr. Louis Bell, who recently made such a valuable test of the operation of the road at Lafayette, Indiana. Dr. Louis Bell, as the result of his investigations, considers that the economy of the storage battery traction system is at present doubtful. It costs distinctly more than traction by direct supply, and probably more than traction by horses, unless under specially favourable circumstances. I need not go into the figures, which are presented in some detail, and appear to be exact; but there is one point to be borne in mind which these statistics do not bring out, and that is that the comparison between storage batteries and horses, or even between storage and direct overhead systems, has not yet been made on equal terms. By that I mean that where a horse railroad will sometimes have as many as 2,000 horses, and an overhead road will have no fewer than 40 or 50 cars, storage roads, so far, have to compile their statistics on the operation of at most three or four cars. Hence we have, so to speak, an unfair comparison of retail figures with wholesale figures, and obviously to the disadvantage of the former. This consideration comes out in a remark which Dr. Bell makes on the life of the batteries. It has been suggested that the car companies would do well to reconstruct the positive plates from the disintegrated material of the old ones. From a practical point of view, Dr. Bell says that this is about as feasible as rewinding their burnt-out armatures, or casting new trolley wheels out of the scraps of the old. He believes that no company of moderate size could profitably undertake this sort of work. That is just the point, and there is no reason why a company of something other than moderate size should not do it. A great many of the local electric lighting companies now do their repairs and reconstruction in their own workshops very economically, and there is no reason why an electric railway company, however operated, should not enjoy the same advantages. Moreover, the question arises whether we are to consider the present conditions obtaining with storage cars permanent and final, or whether we are not to expect radical improvements in the weight and capacity and durability of the batteries. Taken altogether, however, Dr. Bell's Paper is a valuable discussion of the state of affairs as we find it, and probably his suggestion as to improving the economical ratio and the means of doing so will be carefully noted and acted upon. While, as I have remarked before, the question of profit is one which street-railway men have con-

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sidered as closely as anybody else in any other industry, there are incidental advantages to the principle of storage cars that must always strongly recommend them for public favour, and it is just these reasons that make the Julien cars now running in this city on the Fourth Avenue road so popular with passengers. Everybody likes to ride in them, and is willing to wait for them, skipping the intervening horse-cars.

Yet another item of street-railway news, and I will leave the subject for the present. It is worthy of note that the Brush Electric Company here have recently taken up the short series railway system, and that they are reported about to equip a road with it in Muskegon, Mich. This will be a nice little road, the equipment including four and a-half miles of new track, five new motor cars, added to the existing rolling stock, a Brush generator of 125 horse-power, and a complete station equipment. Overhead construction is to be used. It is understood that various changes and improvements have been made in the apparatus, and that under the new conditions it will have a thorough trial as to its value.

As you are probably aware, our connections with Japan are very close. The Japs are to be frequently seen on our streets and in public places, and a great many of them are actively engaged in business. Japan has been a good market for American wares, and for none more than electrical apparatus. There is a good deal of electrical lighting being done in Japan, chiefly on the Edison system, and there is a prospect of considerable advances. It cannot be said that the Japanese have shown themselves very inventive in the domain of electricity; but I have heard the remark made more than once that they show themselves remarkably skilful in their close imitations of American machinery. From time to time we are favoured with visits from Japan of representative men investigating electrical matters, and just now we have among us Mr. S. Oi, who is connected with the Japanese Government service. Mr. Oi is studying the quadruplex, as employed in this country, and proposes on his return to Japan to introduce it there, as there are some circuits upon which it can be used to advantage. Mr. Oi says that the Government is very liberal in its extension of electrical facilities, and that a large and growing telegraph business is done, especially in connection with the Stock Exchange and the rice trade. Mr. Oi states that owing to the rapid multiplication of wires the streets of Tokio in some places are like those of New York, but that there is not yet any yearning for a subway board. Mr. Oi states also, as an evidence of the interest in electricity, that the National Electrical Society of Tokio has a total of 1,015 members, most of whom are connected with the telegraph and telephone, although some, of course, are interested in the electric light. There is no doubt that Japan will continue to prove a good market for American electrical productions, and that it will not be satisfied unless it has every improvement and development that is to be found here.

Quite an interest is being taken at the present time in the system of magnetic ore-separators. This is largely due to the fact that Mr. Edison has lately been perfecting an apparatus for separating ores, and that it is now at work in various places, with what are reported to be excellent results. There is a vast amount of material offering for this kind of treatment, and there seems no reason why the application should not prove remunerative in a great many places. It is said that numerous applications are being made in the Patent Office for improvements in this field, and it may be noted that recently various patents have been issued for this class of apparatus. Among those who are thus shown to be working at the subject is the well-known physicist and electrician, Prof. W. A. Anthony, who is now connected with the Mather Electric Company.

Mr. C. E. Mitchell, Commissioner of Patents, has recently filed with the Secretary of the Interior a preliminary report of the operations of the Patent Office for the year ended June 30th, 1889. This report gives, as usual, remarkable evidence of the activity in this country in the field of invention, and particularly in the department of electricity. There were received during the year no fewer than 36,740 applications for patents, 808 applications for design patents, 101 applications for re-issues and 2,345 caveats. The number of patents granted during the year, including re-issues and designs, were 21,518, and the total number of patents granted in this country in the year reaches considerably over 400,000, of which about 300,000 are in existence and operation. With regard to the subject of legislation, the Commissioner says that some of the provisions should be altered, especially those relating to the date of patents and the duration of patents for inventions previously patented in a foreign country. Mr. Mitchell is also of opinion that the policy or practice of the patent office in adjudicating upon questions arising in regard to the granting of patents should be made to conform more nearly with the decisions of the Federal Courts. There is a great deal of trouble continually on this score, and it does not seem as if any permanent relief can be reached in the matter until definite shape is given to patent litigation by bringing it under the final review of a Patent Court established as a branch or special section of the Supreme Court of the United States. This scheme has been proposed, as you are aware, with general endorsement, and I should not be surprised to see it brought up and carried through at the next meeting of Congress.

CORRESPONDENCE.

THE DEFINITION OF IMPEDANCE AND THE PRACTICAL UNIT OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There would appear, from Mr. Blakesley's letter in your last issue, to be some misunderstanding as to the resolutions of the Paris Congress adopted by the Electrical Standards Committee. The three resolutions in question in his original French run as follows:—

"1. *L'Intensité Efficace* est la racine carrée du carré moyen de l'intensité du courant.

"2. *La Force Electromotrice Efficace* est la racine carrée du carré moyen de la force electromotrice.

"3. *La Resistance Apparente* est le facteur par lequel il faut multiplier l'intensité efficace pour avoir la force electromotrice efficace."

The Committee accepted the first two of these definitions. With regard to No. 3, they preferred to restrict the term "resistance" to actions purely dissipative in their nature, and adopted instead of "resistance apparente," or its exact English equivalent, the term "impedance." They have, as you point out in your Editorial Note, merely widened the meaning of the term, which had originally been restricted by its distinguished author to the case of sinusoidal currents. Some of the points raised in the discussion are given in Dr. Lodge's interesting sketch of the Electrical Papers in Section A, which appeared in your issue of October 4th.

I should like also to make a few remarks with regard to Prof. Ayrton's Paper "On the Practical Unit of Self Induction." The question seems to me to turn very much on what is meant by the word "practical" used in connection with electrical units. The term occurs, I think, originally in the first report of the Electrical Standards Committee B. A. Report, 1862 (Reprint, p. 9). Quoting a letter from Dr. Esselbach, the engineer of the Malta and Alexandria cable (the letter is given in full in the appendix), the Committee say, "Thus, his first conclusion is to adopt Weber's absolute unit substantially, and to derive from it by the multiple 10^{10} the practical unit. This practical unit is precisely that recommended by your Committee." The multiple is 10^{10}, because the fundamental unit of length employed by Weber was the millimetre. Again, Maxwell (Vol. II., § 629), on Practical Systems of Electric Units, writes:—"Thus the practical unit of resistance is called the ohm, and is represented by the resistance coil issued by the British Association and described in Art. 340. It is expressed in the electro-magnetic system by a velocity of 10,000,000 metres per second;" while, again, in 1881, the Paris Congress adopted the following resolutions (*Nature*, Vol. XXIV., p. 512):—

1. The fundamental units for electrical measurements to be the centimetre gramme and second.

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2. The practical units "ohm" and "volt" to retain their present definitions—10^9 for the ohm, 10^8 for the volt.

As I understood the intentions of the Committee, the word "practical" in the definition of the electro-magnetic unit of self-induction is to have the same meaning as it has above. The absolute unit of electro-magnetic induction is the centimetre. The "practical" unit is 10^9 centimetres, and this is to be called a "quadrant." No doubt another meaning might be given to "practical"; if we interpret it as equivalent to "legal" in the term "legal ohm," then Prof. Ayrton's criticisms are justified. The legal unit of electro-magnetic measure would not be 10^9 centimetres, but somewhere about $\cdot 99777 \times 10^9$ centimetres, as Prof. Ayrton points out, but I feel sure this interpretation was not intended by the Committee.

It was felt that it was desirable to emphasise the fact that the self-induction of a simple coil in electro-magnetic measure was a quantity which could be determined with a metre scale or something equivalent to such a scale. Most observers will continue, at any rate until Professors Ayrton and Perry put their new standards of induction into the hands of electricians, to measure coefficients of induction by means of a time and a resistance. The resistance, however, was originally determined in terms of a time and a coefficient of induction calculated simply from the linear dimensions of a coil or disc. The coefficient of induction is necessarily the more fundamental quantity of the two; is it desirable to give it a name such as "secohm," which appears to derive it from its own offspring? Prof. Ayrton graduates his voltmeters in "legal" volts. Let me ask him to graduate his new Standards of Electro-Magnetic Induction in "legal quadrants."—I am, &c., R. T. GLAZEBROOK.

THE PRACTICAL UNIT OF SELF-INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Under the above title Prof. Ayrton, in your last issue, directs attention to the dilemma in which electricians have been placed by the Paris Electrical Congress and the Electrical Standards Committee of the British Association through their adoption of 10^9 C.-G.-S. units as the *practical unit* of self-induction, and to which the name "Quadrant" has been given. That 10^9 centimetres is not the practical unit is quite evident from the article above referred to, so no more need be said on that point; but it seems desirable to inquire whether anything has been gained by substituting "quadrant" for "secohm."

Perhaps some of the members of the Standards Committee can furnish conclusive arguments why the new name is preferable to the old one, but until then I venture to think that practical electricians who have to measure coefficients of self-induction will consider the change undesirable.

The name "quadrant" seems objectionable from several points of view.

First, the word already has several different meanings attached to it, *e.g.*, in geometry, gunnery, mechanism, and astronomy, and giving to it yet another meaning would be likely to lead to ambiguity. The confusion that arises from the promiscuous use of "induction" should be sufficient to condemn the use of the word "quadrant" as the name of the unit of self-induction.

Secondly, the name will serve to perpetuate error by preserving the notion that a coefficient of self-induction is a length. Of course every one knows that the dimensions of self-induction in the electro-magnetic system is L, but this result is arrived at by suppressing the dimensions of "permeability."*

It is also well known that in the electrostatic system, its dimensions are $L^{-1} T^2$, *i.e.*, $\frac{1}{\text{acceleration}}$, and therefore we could say that a coefficient of self induction is the inverse of an acceleration. That one and the same thing cannot be two totally different things seems too evident to need proof.

As an example of how one may be led into error by calculating the self induction of a coil from its linear dimensions, I may cite a case in which the *calculated* coefficient of a 10,000 ohms coil was of the order ·00003 "secohms," whereas its *measured* coefficient was 10 secohms. Thirdly, if the word quadrant is intended to suggest any well-known length (as I suppose it is), that length is the length of the earth's quadrant, and here again a discrepancy exists, for the earth's quadrant is not 10^9 centimetres, but, according to Captain Clark's determination, $1{\cdot}00074 \times 10^9$ centimetres, a difference of nearly a tenth per cent.

Fourthly and lastly, the word "secohm" has come into general use amongst those who make commercial measurements of coefficients of self-induction, and as the word is short, explicit and expressive, it would be a great misfortune to replace it by one open to such serious objections as the word quadrant.—Yours, &c., T. MATHER.

* *See* Prof. Rücker "On the Suppressed Dimensions of Physical Quantities."—*The Electrician*, Vol. XXII., pp. 108-9.

"THE A. B. C. OF ELECTRICITY."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to make a few remarks respecting the criticism of "The A. B. C. of Electricity" by Mr. W. H. Meadowcroft, contained in your issue of September 20th, 1889.

The style in which the book is written as being for children (your critic states for children of only six or eight years of age) has been to many of its older readers its great charm. There are a number of instances which have come to my attention where gentlemen largely interested financially in electric lighting, have said that this book gave them the first information they had ever been able to understand regarding the terms and general characteristics of electricity. Though the book was written primarily for children, and was originally intended to appear in the columns of a children's magazine, it was found useful to those desiring to know a little regarding electricity, and was published to satisfy a want. Mr. Edison's endorsement was one which covered merely the correctness of the statements, and was to the effect that the "treatment of the subject and arrangement of the matter have impressed me favourably." This recommendation was given by Mr. Edison as a personal favour to Mr. Meadowcroft, who had been on friendly relations with him for ten years, and was done entirely in a spirit of friendship, and after a very careful perusal of the MSS. personally, and under the advice of several of his assistants who had also read the MSS.

Your criticism specifies several cases of supposed inaccuracy. The first is the one which you quote as follows:—

"We all know that if you have a pound of water you must have something to hold it because it has weight, and consequently occupies some space. But electricity itself has no weight, and therefore cannot occupy any space."

If the words "therefore cannot" were changed to "does not" your whole criticism would fall.

The next criticism, about reckoning the pressure of water. I think that the critic would find great difficulty in putting this explanation into homely language in other phrases than Mr. Meadowcroft has used when he speaks of the pressure to the square inch of water. The moment more elaborate explanations are attempted the book would be robbed of some of its simplicity, without adding to any of its usefulness.

Regarding the criticism of the sentences which, in the words of the book, are as follows:—

"We might mention, as another analogy, the pressure of steam in a boiler, which is measured or calculated in pounds just as the pressure of water is measured. So we might say that 100 pounds steam pressure used through the medium of a steam engine to drive a dynamo, could thus be changed to electricity at 100 volts pressure."

This, Mr. Meadowcroft informs me, was suggested to him by Mr. Edison as a simple method of using the words so that an ordinary reader might understand them, and for the purpose of giving a clear example of the meaning of the word "volts."

Your next criticism is on the following sentences:—

"The only way we can get electricity to do useful work for us is to put some resistance or opposition in its way. So you see that if we make it travel through the wire around the iron or steel there is just enough resistance or opposition in its way to give it work to get through the wire, and this work produces the peculiar effect of making iron or steel magnetic."

The critic is entirely mistaken in his criticism. If he would give due weight to the word "opposition" as previously

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defined in the book, he would find that Mr. Meadowcroft has given a sufficiently exact description, in a few words, of the phenomenon in question.

Regarding the criticism on Mr. Meadowcroft's description of a commutator, I would call attention to the fact that he has simply described one use of the commutator, namely, the collection of the current. He did not attempt any description of its use "to rectify the alternation of the current," as that would have been too technical for the purposes of his book.

Mr. Meadowcroft's explanation of the phenomena which occurs in the incandescent lamp is as follows:—

"You see it is a struggle between the carbon and the electricity, the current being determined to go on, and the carbon trying to keep it back, and in the end the electricity being the strongest gets the best of it; but the struggle has been so hard that the carbon has been raised to a white heat, and so gives out a beautiful light, which continues as long as the current of electricity flows."

This statement seems to me absolutely correct, and gives the phenomena in such words as can be comprehended by readers who have no technical knowledge of electricity.

I desire to protest against the criticism which is made on Mr. Edison. Mr. Edison is a man who has for many years been a hard and successful worker. I think that considering the great service which Mr. Edison's inventions have been to the world, that an electrical journal which claims to be the leading electrical journal in England should not criticise a friendly remark of his by drawing into it what ill-founded rumour gives as the gossip of the United States—namely, that he "is the inventor of electric lighting," &c.

Mr. Edison is not to blame for the fact that, having been a prolific inventor, he has been credited with more than he has accomplished. What he has accomplished entitles him, in a paper like *The Electrician*, to dignified consideration and criticism, to say the least.—Respectfully yours,

FRANCIS R. UPTON.

Orange, New Jersey, U.S.A., October 3rd, 1889.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

October 7, 1889.

15,700. W. B. SAYERS. London. Improvements in dynamo machines for electro-plating.

15,721. H. GROSSMITH. Glasgow. Improvements in electric motors.

15,733. E. DUCRETET. London. Improvements in electrical signalling apparatus.

October 8, 1889.

15,769. Sir W. THOMPSON. Glasgow. Apparatus for measuring and recording electric currents.

15,775. C. F. WINKLER. Manchester. Improvements in electro-dynamic and dynamo-electric machines.

15,819. W. F. SMITH. London. Improvements in devices for connecting the plates of one electric battery with another battery or batteries, and with a switchboard or transmitting device.

15,820. W. F. SMITH. London. Improvements in frames for supporting the plates or elements of a secondary or storage battery.

15,821. S. C. C. CURRIE. London. Improvements in the method of electrolytically reducing plates of metallic salts to a metal state to "form" the electrodes of secondary or storage batteries.

October 9, 1889.

15,840. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. London. A new and improved meter for electric and other purposes, and for the differential actuating movement thereof.

15,848. J. A. SHELTON. London. Improvements connected with kerbings of pavements as means or apparatus for containing electric and like wires, gas, water and other pipes, or the like.

October 10, 1889.

15,936. J. ROBSON. Hanlsworth. Methods and apparatus for cleaning electric lamps.

15,958. F. W. ENGLEBACH and E. B. BRIGHT. London. A method of and appliances for preventing excessive heating or undue expansion of electric mains or surface conductors through excess of electricity, and, if convenient, utilising such excess.

15,963. P. SCHOOP. London. Improvements in the manufacture of electrodes or plates for electrical purposes.

15,967. W. C. JOHNSON and S. E. PHILLIPS. London. Improvements in insulating supports for overhead electrical conductors.

SPECIFICATIONS PUBLISHED.

1888.

13,622. DE FERRANTI. Electric meters. (Price 8d.)

16,257. BROWN. Arc lamps. (Price 8d.)

16,625. ANDERSON. Electric arc lamps. (Price 8d.)

1889.

5,241. JUSTICE (Greene). Magneto generators. (Price 8d.)

12,437. FLINT. Electric drinking vessels. (Price 6d.)

12,752. MORRIS and SALON. Secondary battery plates. (Price 8d.)

13,135. LAKE (Gray and Sovy). Coin controlled telephone. (Price 6d.)

1887.—Reprint (with alterations).

7,530*. STATTER. Electrical transformers. (Price 8d.)

COMPANIES' MEETINGS & REPORTS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The following is the report and accounts of the Directors for the half-year ended 30th June last, to be submitted to the thirty-second ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, London, E.C., on Wednesday, the 23rd inst., at 2 o'clock:—

The gross receipts, including Government subsidies, have amounted during that period to £256,757. 3s. 2d., against £239,926. 0s. 5d. for the corresponding half-year of 1888.

The working and other expenses, including £22,626. 1s. 8d. for cost of repairs to cables and expenses of ships, absorb £73,773. 10s. 2d., against

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
VULCAN PHOSPHOR
DURO METAL
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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£69,297. 10s. 11d. for the corresponding period of 1888, leaving a balance of £182,983. 13s. From this is deducted £2,652. 11s. 4d. for income tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £138,736. 1s. 8d. as the net profit for the half-year, against £125,804. 9s. 1d. for the corresponding period of 1888. Against this the Directors have charged £50,000 on account of the Western Australian Cable.

One quarterly interim dividend of 1¼ per cent. amounting to £31,250 has been paid during the half-year, and another of like amount will be distributed on the 15th instant, leaving £26,236. 1s. 8d. to be carried forward.

During the half-year under review the Saigon end of the Saigon-Hong Kong Cable has been partially renewed, and the cost of the operation, amounting to £8,092. 11s. 7d., charged against the reserve fund. Since the 30th June a further length of 127 nautical miles has been renewed, leaving only about 14 miles to complete the renewal of the shallow water portion off Saigon. This, together with the renewal of the shallow water portion of the Kong Kong end of the cable, will shortly be carried out.

The Company's maintenance ships have, as usual, been employed on various cable repairs, but no interruptions affecting the revenue have occurred during the past six months.

The South Australian Government land line between Port Darwin and Adelaide has been well maintained during the half-year under review.

The Monte Video Telephone Company (Limited).

The following is the report of the Directors of this Company to be presented to the shareholders at the annual general meeting, to be held at the offices of the Company, No. 25, Abchurch-lane, at 2 o'clock p.m. on Friday next:—

The first annual statement of accounts, made up to 31st July last, shows a profit of £10,439. 15. 10d. Off this sum there has been written £114. 14s. 8. for preliminary expenses, and £22. 2s. 9d. for depreciation of furniture, leaving a balance of £10,302. 18s. 5d. The Directors recommend that of this amount the full dividend of 6 per cent. be paid on the Preference Shares, which absorbs £7,290, leaving a balance of £3,012. 18s. 5d. which is applicable to a dividend on the Ordinary Shares. They further recommend that a dividend of 2½ per cent. be paid on the Ordinary Shares, that £1,000 be placed to renewal fund, and that the balance of £325. 8s. 5d. be carried forward. An interim dividend on the Preference Shares was paid in March last. As already notified to the shareholders, it was deemed expedient to purchase in December last the business of the Monte Video branch of the River Plate Telephone and Electric Light Company (Limited), and thus consolidate the telephone interests in that city. During the year the sum of £9,646. 18s. 9d. has been expended on capital account, in consequence of the amalgamation of the telephonic interests now under the control of this Company, and in providing the requisite plant for the most efficient telephonic service possible, such as the multiple switch-board, aerial cables, &c. This perfection of the system should result in a large accession of subscribers. In order to meet this exceptional expenditure the Directors have arranged for the issue of a portion of the unallotted capital of the Company under the powers conferred upon them. The Directors feel justified in congratulating the shareholders on the result of this first year's working, and in view of the general prosperity of Uruguay, and the arrangements they are now making for augmenting the Company's business, they feel confident of improved results in the future. In accordance with the Articles of Association, Mr. Arthur Holland retires from the Board of Directors, but, being eligible, offers himself for re-election. The auditors, Messrs. Gerard Van de Linde and Son, also retire, but offer themselves for re-election.

NORTHAMPTON ELECTRIC LIGHT AND POWER COMPANY.—A meeting of the subscribers to this company was held on Friday last, in consequence of shares not having been applied for in sufficient numbers to permit the carrying out of the original scheme. Out of 50,000 £1 shares announced in the prospectus issued a month ago, only 7,500 were subscribed for. The directors withdrew the prospectus, and proposed an alternative scheme, involving the expenditure of £10,000 only. The subscribers agreed to this and over 1,000 more shares were immediately taken up in the room.

NEW COMPANIES REGISTERED.

THE ELECTRIC ARMS AND AMMUNITION SYNDICATE (LIMITED).—This company has been registered with a capital of £40,000, in £100 shares. Objects: To enter into an agreement with the American Electric Arms and Ammunition Company to purchase certain patents and inventions. To use, develop, grant licenses in respect of or turn to account the same, and carry on any business which may be deemed directly or indirectly to benefit the company. The first subscribers are:—Major C. B. Waller, C. A. Pierce, Colonel E. Villiers, Jas. Pender, Captain J. Balfour, Major J. J. Wright, and T. Gemmell. There are to be not less than three nor more than seven directors, the first to be appointed by the subscribers to the memorandum of association.

MIDLAND ENGINEERING COMPANY (LIMITED).—This company has been registered with a capital of £100,000, in £5 shares. The object of the new company is to purchase the manufacturing rights of the Beck Gas Engine for the United Kingdom, India, Victoria, South Australia, Queensland, New South Wales, and elsewhere, and the following patents, viz., Poore, Ingrey, and Latham's rotating high-speed engine, Wansborough and Evans' safety automatic low-pressure motor, and Evans' exhaust pressure and blast fan, also the freehold property and works known as the Sandmere Engine Works, near Nottingham. Amongst the first subscribers we notice Mr. H. Sherley Price, of the well-known firm of Wheatley Kirk, Price and Goulty, 52, Queen Victoria-street, E.C. There is not to be less than three nor more than seven directors. Qualification, £500. The first directors are W. Laurence William, J. W. Restler, R. E. Commens, and R. K. Evans.

CITY NOTES, &c.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—At a meeting of the board of directors of this company held on Friday last it was resolved to declare an interim dividend for the quarter ended 30th September last of 12s. 6d. per cent. on the Ordinary Stock and 25s. per cent. on the Preferred Stock, less income-tax, payable on the 1st November to the stockholders registered on the books of the company on the 7th October, 1889.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended October 11, 1889, amounted to £3,793.

CITY OF LONDON AND SOUTHWARK SUBWAY COMPANY.—The offices of this company have been removed to the Company's City Station, 46, King William-street, E.C.

THE DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The board of directors of this company on Friday last resolved upon the payment of an interim dividend of 3s. 6d. per share, free of income-tax, being at the rate of 3½ per cent. per annum, for the quarter ended 30th September last. The dividend is payable on and after the 24th instant.

ELECTRICITY SUPPLY COMPANY FOR SPAIN.—The allotment letters to applicants for shares in this company have been posted.

THE SCHMIDT-DOUGLAS ELECTRIC COMPANY, (LIMITED).—With reference to the liquidation proceedings connected with this company, we understand it is not expected that, after paying the debenture holders, anything will be left for the trade creditors.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 11, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,749.

CHANGE OF NAME.—The Globe Electrical Engineering Company announce their intention to change their designation to the Globe Electrical and Art Fittings Company.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

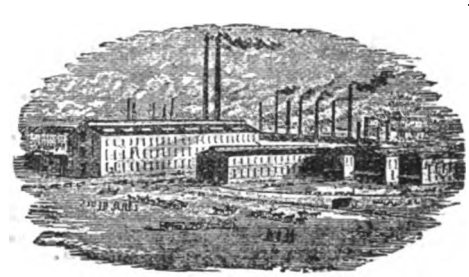
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.


FACTORY.

MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Oct. 16, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 16, 1889.	
					£ s. d.		Highest.	Lowest.
			TELEGRAPHS.					
£ 1,770,360	Stock	15/0	Anglo-American	51¼ 52½	4 15 3	Jan., Apr., July, Oct.	53⅜	52¼
2,614,820	Stock	30/0	Do. Preferred	88 89	5 12 4	,, ,,	90¼	87½
2,614,820	Stock	...	Do. Deferred	17¼ 17⅜	...	February	17⅜	17¼
130,000	£10	5/0	Brazilian Submarine	13½ 14	5 14 4	Mar., June, Oct., Dec.	14	13½
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10¼ 10½	5 18 11	Jan., Apr., July, Oct.	10⅝	10½
380,000	10	5/6	Eastern	13¼ 14	4 12 0	,, ,,	14	13¾
70,000	10	6%	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	...	...
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	111	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13 13/16	13 7/16
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	106	...
179,177	10	4/0	Globe Telegraph and Trust	8⅝ 8⅞	5 4 3	Jan., Apr., July, Oct.	9	8 1/8
178,992	10	3/0	Do. 6 per Cent. Preference	14¼ 15	4 0 0	,, ,,	...	...
150,000	10	5/0	Great Northern	15¼ 15¾	4 15 3	Jan., July, and April	15½	15¼
17,000	25	37/6	Indo-European	42 44	5 13 8	April and October	43	...
9,000	8	8/0	Reuter's	6½ 7	5 14 3	April and October	...	...
15,609	10	5/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101¼	101
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	...	...
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	126½	...
88,321	10	nil.	West India and Panama	2¼ 2⅜	...	...	2 3/16	2 1/16
34,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12¼	11⅞
4,669	10	*	Do. 6 per Cent. 2nd Preference	14½ 15⅜	...	...	...	...
45,181	15	9/0	Western Brazilian	9½ 10	7 10 11	March & September	10¼	9¾
1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	1/16 1/8	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 4	...	...	...
55,000	5	...	United River Plate	5 5½	...	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	5 5⅛	...	...	...	...
23,692	5	2/0	Do. (fully paid)	5 5⅛	...	February & August	5¼	5
79,934	5	...	Swan United (£3. 10s. paid)	5⅛ 5⅜	...	...	5⅜	5⅛
500,000	10	...	Metropolitan Electric (£3 paid)	3¾ 4¼	...	...	4⅛	3¾
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 45	5 6 8	March and July	45⅜	45⅛
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	19	18⅞

* No dividend since May, 1880.

JABLOCHKOFF'S

DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

Anglo-American Brush Electric Light Corporation, Limited.
Crompton & Co., Limited.
S. Z. de Ferranti.—London Electric Supply Corporation, Limited.
W. T. Goolden & Co.
Hammond & Co.
Wilson Hartnell.
Johnson & Phillips.
Nalder Brothers & Co.
Paterson & Cooper.
Ernest Scott & Co.
Siemens Brothers & Co., Limited.
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3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 597.—Vol. XXIII. FRIDAY, OCTOBER 25, 1889. Price Fourpence.

NOTES.

By a very large majority the City Commission of Sewers on Monday last sent back for reconsideration the report of its Committee on the question of lighting the main thoroughfares by electricity. The effect of this decision will be to again delay the introduction of the electric light into the City area for a considerable time longer, probably until the several companies now applying for them have obtained statutory powers in the next Session of Parliament. No doubt by that time Mr. Sly will have satisfied himself as to the increase of illumination which the electric light would afford, while Mr. Shaw will have learnt the true value of the "new economical system" he has heard of "which could be worked without a dynamo." Lastly, the whole body of Commissioners may be brought to reflect that public convenience in the richest city of the world is not to be put off by pleas of economy which are never heard of except when the Commission has a strong bias against any project on which money has to be spent. For reasons which are not very apparent the City authorities have certainly adopted an obstructive attitude towards electric lighting. Ostensibly their present objection is mainly to the terms of the proposed contracts; but as the contractors would be only too glad to modify the conditions, we can but suppose that the real cause of opposition is kept in the background because it cannot be openly stated.

In a letter to *The Times* of Friday last, Prof. Osborne Reynolds calls public attention to the question of a national memorial to the late Dr. Joule in the following words:—

"Sir: Although the unfortunate delay which took place in publicly announcing the death of the late Dr. Joule precluded the possibility of any steps being taken to secure his interment in Westminster Abbey, it would seem fitting that a national monument should be erected to one who has secured to this country the honour of the greatest physical discovery since the time of Newton, a discovery which has produced enormous effects, material as well as scientific; and I would suggest, through your paper, that steps should immediately be taken to put in hand such a monument, and to obtain, if possible, the consent of the Dean to its erection in Westminster Abbey."

We cordially endorse the above expression of opinion. The services rendered to the cause of human progress by the classical researches of this great experimentalist ought to be commemorated in some outward and visible form. The immense revolution in human thought effected by the doctrine of the conservation of energy has only been rendered possible by researches which subjected the theory of the indestructibility of energy to the tests of an experimental scrutiny of the highest and most rigorous kind. A life-long work of this nature is not one of a character which actively affects the public imagination, but the enormous value of it can best be tested by supposing ourselves to be still living in ignorance of its results. A memorial to commemorate these splendid achievements is certainly called for. That it should be a national memorial is only fitting and right.

The results of Dr. Joule's scientific work have been digested and reproduced in so many text books and treatises that there are not many students even of an advanced knowledge who have a direct acquaintance with the original Papers themselves. They are well worth study as models of experimental researches of a quantitative nature absolutely unsurpassed in painstaking accuracy of the highest kind. In some of his investigations on the mechanical equivalent of heat, the loss of energy due to the noise made by the revolving apparatus was even estimated and allowed for by experimentally determining the work required to be done to produce an about equal sound by the movement of the bow of a violoncello across its strings. The Papers abound in striking examples of the wonderful skill, patience and inventiveness of Dr. Joule in dealing with the difficulties involved in correcting the results of observation.

The facts set forth in the lecture on "Electrical Transmission of Power in Mining Operations," recently delivered by Mr. Albion T. Snell at Wigan, which we print in another column, show very clearly that the fusion of the mechanical and the electrical engineer to which Prof. Perry alluded in his presidential address to the Junior Engineering Society is already bearing good fruit. In spite of the many unfavourable circumstances attendant on mining work, not only was the lecturer able to record a complete absence of breakdowns of the electrical plant, but he was able to show an efficiency from the engine cylinder to the pumps of considerably over 40 per cent., a result certainly due as much to good mechanical design as to sound electrical knowledge. It is interesting to notice that under precisely similar conditions the efficiency of the now discarded air plant did not exceed 14 per cent. at the best.

We publish in another column a brief account of the Slattery Alternate-Current Meter. The details of this meter which have come to hand are hardly sufficient to enable us to judge exactly wherein it differs in principle from the Shallenberger meter described in *The Electrician* of September 7th, 1888. It appears that the retarding force against which the electric

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current does work is produced by the air-resistance to revolving vanes, and that, as at very high speeds this resistance varies as a somewhat higher power than that of the square of the speed, the exposed vane-surface is made to diminish automatically and reduce the resistance.

Our New York correspondent furnishes us this week with a very complete summary of the judgment, to which we alluded in our last issue, and which was recently given in the United States Circuit Court at Pittsburg, in the action brought by the Consolidated Electric Light Company against the McKeesport (Pa.) Local Edison Company, for the infringement of their Sawyer-Mann patent of 1885. The chief claim of this patent, which is owned by the Westinghouse Company, is for "an incandescing conductor for an electric lamp, of carbonised, fibrous, or textile material, and of an arch or horse-shoe shape." The Judge, it seems, narrowed down the patentable features to the fibrous filament conductor, and then decided that not only was this nothing new, but that the original intention was to secure a patent for the carbon arch. *The* great discovery, according to Judge Bradley, was the employment of a high-resistance filament. It would seem, therefore, that the first claim in Edison's (English) Patent, No. 4,516, of 1879, is as unassailable in the United States Courts as it has hitherto proved in England.

The approach of winter finds the Londoner defenceless as ever against the Fog Fiend. It is true that the County Council has appointed a Committee to consider whether anything can be done, but the question is one requiring the fullest and most competent scientific knowledge. It is, therefore, hopeless to expect that the County Councillors can provide an adequate remedy, though they may do useful work by enforcing the Smoke Abatement Act. Nevertheless, as all electricians are aware, there is some reason to think that the resources of science may yet prove adequate at least to alleviate if not to remedy the evil. The *Morning Post*, writing on the subject, suggests the appointment of a Royal Commission, consisting of specialists of the first rank, to grapple with the problem, and we would heartily endorse the suggestion. The Registrar-General's returns show that last year in London alone during three foggy weeks the deaths exceeded the average by no less than 1,400; and as for the financial aspect, it is, we believe, generally admitted that fog costs Londoners, at the very least, £2,000,000 per annum.

Amongst the many Bills which the London County Council will be responsible for in the next Session of Parliament is one dealing with overhead wires. The powers which the Council propose to obtain are only such as ought to rest with any important municipal body, and if they are administered in a proper spirit nothing but good will result, though, of course, now that all the Electric Supply Companies have been brought under stringent statutory obligations in this respect, the field of operations of the Council's Inspectors will be considerably narrowed. The removal of ownerless and the registration and inspection of the remaining wires will, however, give the Council enough to do for the present.

In *The Times* of Oct. 21 Prof. Silvanus Thompson sounds a mournful note on the subject of the possible or even actual entry of jobbery into municipal dealings in the matter of Electric Lighting. He calls to mind the indications afforded by recent gas scandals of the existence of jobbery and commission systems in the management of the gas manufacture and distribution by municipal bodies, and hopes that the newer industry of electric lighting will be preserved pure in this matter. We join heartily in the Professor's excellent wishes. Unfortunately, human nature is very much the same everywhere, but it is in the power of all of us to set a good example, and by rigidly setting our faces against any attempt to bias our own judgment in a direction contrary to the merits of the case, to create in this way a high tone which will insensibly be diffused.

Buxton.—At the last meeting of the Local Board it was agreed that any electric lighting scheme should be opposed.

The Japanese Society of Electricians.—This society, although only in existence two years, already numbers 1,015 members.

Bedford.—At the last meeting of the Town Council it was decided to take the necessary steps to secure an electric lighting Provisional Order.

Birmingham.—An accumulator car belonging to the Electric Construction Corporation was tried on the Bristol-road tramway route on Wednesday.

Obituary.—The death of M. Louis Curchod, director of the International Telegraph Bureau, at Berne, was announced in *The Times* of Monday.

York.—None of the tenders for the electric lighting of the new municipal buildings are likely to be accepted, the expense being considered too great.

Lighthouse Illumination.—Tenders will be opened on the 26th inst. at the Prefecture of La Manche for an electric light installation in the Barfleur Lighthouse.

The Van Rysselberghe System in China.—A combined telegraph and telephone line on the Van Rysselberghe system has just been finished in the North of China.

The Late Sir Daniel Gooch.—Our contemporary, the *Railway Times*, with its issue of October 18th, gave a very excellent portrait of the late Sir Daniel Gooch.

Cheltenham.—At a special meeting of the Town Council on Monday it was, after some discussion, unanimously resolved to apply for an electric lighting Provisional Order.

Croydon.—At the last meeting of the Croydon County Council, it was resolved that the Council should apply for a Provisional Order giving to the Council electric lighting powers for Croydon.

Sheffield.—At the last meeting of the Town Council it was decided to appoint a Committee to consider and report upon the desirability of applying for an electric lighting Provisional Order.

Competitions.—The Tower Company invite designs and estimates for a tower of not less than 1,200ft. in height, and offer £500 and £250 for best and second best respectively. Further particulars will be found in our advertising columns.

A Correction.—In Mr. Mather's letter on "The Practical Unit of Self-Induction," which appeared in our last issue, the following correction should be made:—Page 613, bottom line of first column, for 10 secohms read "– 10 secohms."

Glasgow.—At the last meeting of the Town Council the minutes of the Committee on Parliamentary Bills were unanimously confirmed. Among the Bills to be applied for during the next session is one giving the Corporation electric lighting powers.

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Personal.—Mr. A. A. Campbell Swinton is now Messrs. C. A. Parsons and Co.'s London representative for the supply of all their manufactures. Messrs. Parsons will remove into their extensive new works at Heaton, Newcastle-on-Tyne, on the 10th November.

Marriage.—We have pleasure in recording the marriage, on the 21st inst., at Malta, of Mr. W. H. Cottrell, electrician, of the Eastern Telegraph Company, eldest son of Major W. Foulkes Cottrell, late Garrison Staff, Gibraltar, to Louise, only child of Manuel Baglietto, merchant, of Gibraltar.

Sale by Auction.—Messrs. Beal, Son and Chartres announce that (having sold the lease and furniture) they are instructed to sell on Friday next, November 1, the Electrical and Mechanical Plant belonging to the late Sir Charles Bright. Further particulars will be found in our advertising columns.

Rochester.—The Rochester Town Council have decided to adopt electric lighting for the municipal buildings, and the Vines Congregational Church, Rochester, will in future be illuminated with the electric light. This is the first place of public worship in the county of Kent to adopt the light.

The Electric Lighting of the Albert Institute, Dundee.—We hear that the installation in the Art Galleries and Libraries of this institution has proved in every way a success. The contract was carried out by Messrs. Paterson and Cooper, the engine and boiler being supplied by Messrs. Robey and Co.

The Utilisation of the Falls of the Rhine.—The syndicate which was recently formed for the purpose of utilising water-power available at the Falls of the Rhine, at Schaffhausen, hopes to commence the works at the beginning of next year, and to be in a position to distribute electrical energy in 1891.

Hull.—At the last meeting of the Works Committee of the Hull Corporation, deputations waited upon them with reference to the establishment of the electric light in Hull. The deputations were from the National Electric Supply Company, the Kingston-upon-Hull Electric Light and Supply Company, and the House-to-House Electricity Company.

The Telephone in Bolivia.—The telephone line running from Arica to Corocoro, situated in the heart of Bolivia, is probably the most elevated in the world. This line is 187 miles long, and is carried over the Andes at an altitude of 14,500ft. above the sea level. Mr. J. W. Firth, manager of the Arica and Tacna Railway, was the originator of this bold undertaking.

London County Council.—At the last meeting of the Council the report of the Highways Committee was adopted without discussion. It recommended disapproval of some proposed mains of the Westminster Electric Supply Corporation, and approval of some additional mains about to be laid by the Kensington and Knightsbridge Electric Lighting Company.

Proposed Physical Society in Liverpool.—We hear that it is proposed to form a Physical Society in Liverpool, which will hold its meetings at University College, and that Prof. Oliver Lodge has consented to be nominated as first president. A preliminary meeting will be held on November 6th. The secretary (*pro tem.*) is Mr. Thomas Tarleton, 1, Hyde-road, Waterloo, Liverpool.

Obituary.—We regret to announce the death, on Sunday, at Dinard, France, from typhoid fever, of Viscount Torrington, who was chairman from its formation of the firm of Messrs. Crompton and Co. (Limited), and also of the Crompton Electric Light Company, of Australia. Lord Torrington took a deep interest in electric lighting work, and his death is attributed largely to overwork.

Venice.—In a few months it is expected that this city will be entirely lighted by electricity, a contract to this effect having just been signed with a newly-formed company, which calls itself "The Society for the Illumination of Venice by the Electric Light." This company includes many well-known and wealthy Venetian names. The lighting up of the city is expected to be completed within four or five months' time.

The Uranium Mines (Limited).—We publish in our advertisement columns a prospectus of the above company, which, with a share capital of £120,000 in £1 shares, is formed to acquire mining rights, &c., in the county of Cornwall. Sir Alex. Armstrong, K.C.B., F.R.S., is chairman; Mr. A. J. Leese, secretary (*pro tem.*); and the offices are situate at 58, Queen Victoria-street, E.C. The lists close to-morrow (Saturday).

Baudot's Telegraph.—The success of M. Baudot's multiplex apparatus on the subterranean line between Paris and Bordeaux, with relays at Orleans, Tours, Poitiers and Angoulême, has induced the French Telegraph Administration to extend its use in this direction. The Baudot apparatus will, therefore, be shortly at work on the underground lines between Paris and Orleans-Tours, and between Paris and Poitiers-Angoulême.

Technical Education in Japan.—It is reported from Japan that Viscount Ennomoto, the new Minister of Education, is devoting special attention upon the introduction of technical education into the primary schools of the Empire, and that he has turned to Italy as a model. His scheme is to include technical education in the curriculum of the preparatory schools, and to give children technical training from the outset.

Catalogue of Electrical Apparatus.—We have received from Messrs. Ernest Scott and Co., of Newcastle, a very complete and well-illustrated catalogue of some 100 pages, giving full details of the electrical apparatus supplied by them, including dynamos (alternate and continuous-current), arc lamps, incandescent lamp fittings, cables, accumulators, measuring instruments, meters, electric bells, telephones, and a large variety of engines.

The Lighting of the Victoria Station, Bombay.—An experiment with the electric light has been recently tried at the Victoria Terminus, and proved a complete success. The result showed, says *Indian Engineering*, that the proposed change would be a vast improvement on the present gas lighting, and in keeping with the surrounding embellishments of the station buildings. The railway authorities intend introducing the change as soon as possible.

Keynsham.—The opening meeting in connection with the Working Mens' Conservative Association was the occasion of a quick piece of work on the part of Messrs. King, Mendham and Co., who were requested at a very short notice to light the public hall by electricity. A set of accumulators was telegraphed for to London, while a traction engine was secured to drive the dynamo which supplied current to the arc lights. The lighting was in every way a success.

The Edinburgh Exhibition of 1886.—The final meeting of the Association of the Edinburgh International Exhibition of 1886 was held in Edinburgh on Thursday, last week, for the purpose of winding up the Association. The total surplus stood at £5,729. 18s. 3½d., subject, however, to deductions for law charges and the expenses of winding up, reducing the amount for division to £5,447. 4s. 2d. Of this sum £2,000 was granted to Sir James Gowans, and the balance was divided amongst different scientific societies.

Import Duties in Chili.—The following information has been supplied by the Chilian Consul in London in reply to an inquiry made by the Secretary of the London Chamber of Commerce:—"I should say that electrical machinery and electric lighting apparatus imported into Chili would come under the general head of machinery, and be subject to an *ad valorem* duty of 15 per cent. Motors of any class and such-like have a fixed valuation of 25 cents per kilo. The exchange is adjusted periodically. The latest tariff I have is dated 1888, but should the interested parties to whom you refer wish to consult it, I shall be happy to allow them to do so at this office.—Chilian Consulate, 50, Old Broad street, E.C."

The Electric Light in the West.—The machinery of the Exeter Electric Light Works comprises two horizontal non-condensing compound 150 horse-power engines by Messrs. J. Fowler and Co., Leeds, driving two 4,000-light Mordey alternators. For the supply of arc lamps the Electric Light Company is using the Thomson-Houston system. There are two dynamos of this type, each capable of supplying thirty-five arc lamps of 1,200 candle-power each. These are driven by two non-condensing triple-expansion high-speed 30 horse-power

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Westinghouse engines. The steam is supplied to the engines from two Babcock and Wilcox water-tube boilers, working at a pressure of 150lb. per square inch. At present there is sufficient spare power and plant to completely duplicate the whole of the lighting arrangements, and as this power is used fresh plant will be added to insure a continuous supply. The station is designed for a total capacity of 20,000 lamps.

The Edinburgh Exhibition.—We have received the prospectus of the Edinburgh Exhibition of 1890. The Exhibition, as formerly, is under the patronage of Her Majesty the Queen, and the Marquis of Lothian, Secretary of State for Scotland, is again the President. The Vice-Presidents include the Lord Provost of Edinburgh, the Lord Provost of Glasgow, and the Lord Mayor (Elect) of London, Mr. Edison, and Sir John Fowler, the engineer of the Forth Bridge. The Chairman of the Executive Committee is Sir Thomas Clark, Bart., ex-Lord Provost of Edinburgh, and of the London Committee Sir George Haytor Chubb. As we mentioned last week, the executive have secured an excellent site of about 90 acres in extent, within easy walking distance of the centre of the city, and very accessible. The promoters anticipate that the opening of the Forth Bridge early in 1890 will attract a large number of people, and these, added to the numerous visitors who annually come to Edinburgh, will no doubt ensure a success still greater than that achieved in 1886. It is proposed to close the list of applications on 1st December, 1889, the space at the disposal of the Committee being already very largely applied for.

Submarine Telegraphy—Foreign Stations.—On Saturday, the 19th inst., at the residence of Sir John Pender, Foots Cray Place, Kent, there were gathered by special invitation several managers and superintendents from foreign stations now home on leave, connected with the Eastern Telegraph Company, the Eastern Extension Telegraph Company, the Eastern and South African Telegraph Company, and the West African Telegraph Company. The localities represented were Malacca, Rangoon, Alexandria, Gibraltar, Suakim, Zanzibar, São Thomé, &c., &c. After luncheon Sir James Anderson mentioned the circumstance that the day was additionally auspicious from the fact that it was Lady Pender's birthday, and her ladyship's health was drunk with enthusiasm. Sir John Pender complimented the gentlemen present on the ability with which they had sustained their positions, and the prestige it gave to the companies over which he had the honour to preside. The excellent services rendered all round by the various staffs abroad enhanced the importance of the position he occupied. The guests were greatly struck with the beauty of the electric light installation which Sir John had established in his mansion, and which has proved perfectly successful.

Trades Section of the London Chamber of Commerce.—The following are among the agenda of the next meeting of the Committee of this Section:—1. To receive the correspondent's report. 2. To receive result of circular on B.A. screws (specimens of the B.A. screws and screwing tools will be exhibited). 3. To receive result of Standardising Laboratory circular. 4. To consider the instructions of the County Council to their surveyors, and their action in prohibiting their dispensing powers under the Metropolitan Building Act. 5. Commercial education scheme—scholarships and prizes. 6. Report of railway rates question up to date. 7. Fraudulent bills of lading—letters from Sydney Chamber of Commerce and Institute of London underwriters. 8. Dufferin banquet. 9. Trade reports and statistics. We understand that the last five items on the agenda paper for the meeting on Monday are placed there, by order of the Council, for discussion by all the Sections. Both contractors and surveyors are complaining loudly that no discretion is allowed by which the latter may permit trifling deviations from the strict letter of the Metropolitan Building Act without the sanction of that very busy body the County Council itself. This appears to be a matter which might well be entrusted to an Electric Department of the Board of Trade, together with others of a similar character.

A 2,200-Volt Shock.—In a recent number of the New York *Electrical World* Mr. L. S. Day writes as follows:—"On the evening of July 31 my dynamo attendant, Mr. D. I. Phelps, was testing a Brush arc lamp, 2,000 candle-power, which was in the circuit with 44 other lamps, said circuit and lamps being supplied by a Brush No. 8 dynamo. One of the wires became loose in the binding post of the lamp, and in his endeavour to secure it firmly it slipped from the binding post; and as he held the wire in one hand and the binding post in the other, he was put directly in the circuit with the lamps, which had a voltage of at least 2,200 volts, the station ammeter showing 9·1 amperes at the time. Mr. Phelps was thrown to the floor, but did not lose consciousness until he had raised his head from the floor to see if he was clear of the wires. He was then unconscious for two hours and twenty minutes. Bleeding at the arm and the application of a graduated Faradic current were the means used for resuscitation. Mr. Phelps is fully recovered, aside from the severe burns which he received on one hand—the one by which he held the wire—all the fingers being burned to the bone. Can it be explained how he should receive such severe burns as he did upon his tongue? The whole top surface and the edges were burned so that large blisters were formed, and yet there were no contacts made with the circuit but with the two hands."

The London County Council and Overhead Wires.—At the last meeting of the Council the Highways Committee reported that they had considered the question of overhead wires, and they recommended that it be referred to the Parliamentary Committee to prepare and introduce into Parliament in the ensuing session a Bill conferring the following powers, amongst others, upon the Council, namely—1. To compel owners of existing wires to register same, with route plan and other particulars, at the office of the Council within twelve months of the Bill becoming law, such register to be corrected annually. 2. To require, in the case of new wires, plans to be submitted for approval of Council before erection. 3. To remove ownerless wires. 4. To call upon owners to make alterations, repair defects, or renew. 5. To make by-laws and regulations as to length of span across roads and streets, height, mode of support, material and gauge of wires. 6. To authorise, in special cases, attachments to private property, subject to the question of compensation or payment by the wire owners for such privilege, and to the attachments not interfering with the free use of the property. 7. To employ inspectors. 8. To prescribe that wires be carried underground. 9. To charge a fee for annual registration.—The recommendation was approved. It was further resolved that the Council should seek for such powers in regard to subways as might be hereafter decided on.

Electric Railways in Europe.—According to a German return the number of electric railways in Europe at the end of last year was 11, of which the oldest, the Lichterfelde-Berlin Railway was opened in 1881, being 1½ miles in length, with one motor and car, and carrying yearly 100,000 passengers. The latest is that opened at Brussels last year, with five motors and cars. The other lines, their year of opening, length, and number of passengers carried by them are:—From Frankfurt to Offenbach (1884), four miles, with a maximum number of passengers in one year of 990,000; at Brighton (1883), one mile, 1,000,000 passengers in all; at Portrush (1883), six miles, 100,000 passengers a year; from Moedling to Hinterbruche (1884), 2·8 miles, 340,000 passengers; at Blackpool (1884), two miles, 300,000 passengers; at Bessbrook (1885), three miles, 300,000 passengers and 30,000 tons of goods annually; and, finally, at Hamburg, opened last year, and for which there are as yet no returns. There are besides two electric railways in Europe worked for mining purposes, viz., at Zankerode (1884), half-a-mile in length, where 17 motors and cars are used, and at Hohenzollern (1884), where, on a similar distance, 16 motors and cars are used. The working expenses on the two last-named railways, which convey 300 tons of minerals each per day, are respectively ¾d. and 1d. per ton, whereas on the passenger lines they vary from 2d. to 4½d. per car mile. In America there were 13 electric railways opened between 1885 and 1887, being on an average four miles in length. The average number of cars is six, and the number of passengers conveyed annually range from 300,000 to 400,000. It is added that at New York the working expenses worked by horses are 5½d. per mile, against 3½d. per mile when the cars are driven by accumulators.

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A SINGULAR CASE OF DAMAGE BY LIGHTNING.

BY A. P. CHATTOCK.

In the afternoon of the 23rd of last May the wall of a garden in Windmill Hill, Hampstead Heath, the property of Mrs. Inman, was damaged during a thunderstorm in the manner shown in the accompanying drawing (Fig. 1), which is a copy

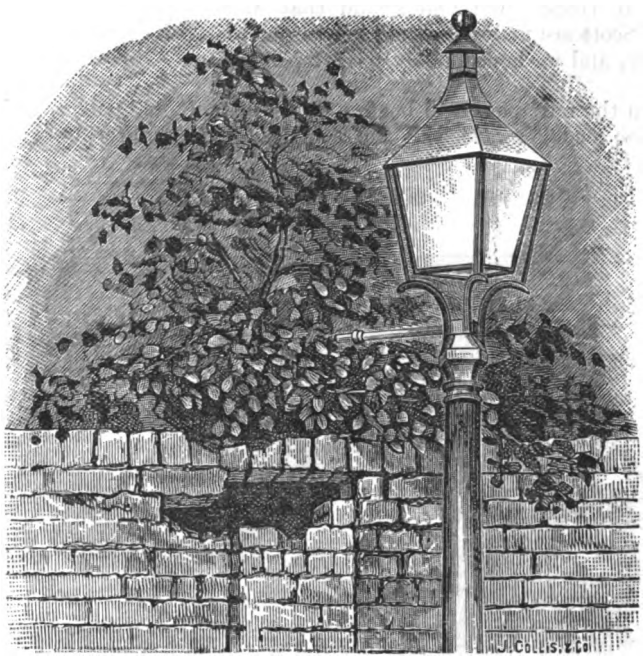

FIG. 1.

of a sketch 1 made on the spot an hour or two after the storm. The wall was completely perforated, the place chosen being at one of the buttresses, but the interesting feature of the case lies in the presence of a lamp-post just opposite, which overtops, and, owing to the narrowness of the footway, almost overhangs the wall. The actual dimensions are given in the diagram (Fig. 2).

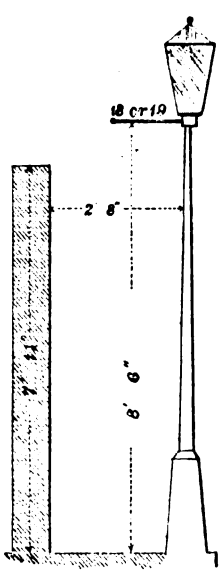

FIG. 2

According to ordinary theories the wall should have enjoyed peculiar immunity from attack at this point, yet the discharge singled out this very spot, and apparently preferred to pass through bricks and mortar under the shadow of a good conductor rather than enter the projecting end of the ladder-rest, which was not 1½ft. distant

There seems to me only one moral to be drawn from these facts, viz., that the flash was what Dr. Lodge calls an "impulsive rush" discharge; either it struck the top of the lamp-post and rebounded sideways along the ladder-rest, as such a discharge probably would, or else, which is quite possible, it entered the wall direct, without noticing the post at all. The presence of the lamp just opposite the hole inclines one rather strongly to the former view, but in opposition thereto is the fact that, so far as I could see, there was no marked indication of melting or burning at the end of the ladder-rest. Either way the case is an interesting one, taken in connection with the late discussions on the subject of discharges, and one only wishes the flash had been actually seen. That this was not the case appears from the following answers to questions, which, through the kindness of Mrs. Inman, I obtained from her gardener, who was in the garden when the accident occurred :—

1. So far as he knew, no one saw the damage done.
2. The bricks fell chiefly into the garden, *i.e.*, away from the lamp-post.
3. The damage could not have been brought about by mechanical means. The wall was in just as efficient repair there as elsewhere.
4. No metal object touched the wall, but some galvanised wire holding up the trees was very near—about 4ft. to 5ft. from the wall, attached to a tree.
5. The time of the occurrence was about a quarter to five p.m.

THE BIRMINGHAM EXHIBITION.

BRUSH ELECTRICAL ENGINEERING COMPANY.—In addition to what was said in *The Electrician*, August 9th, p. 353,

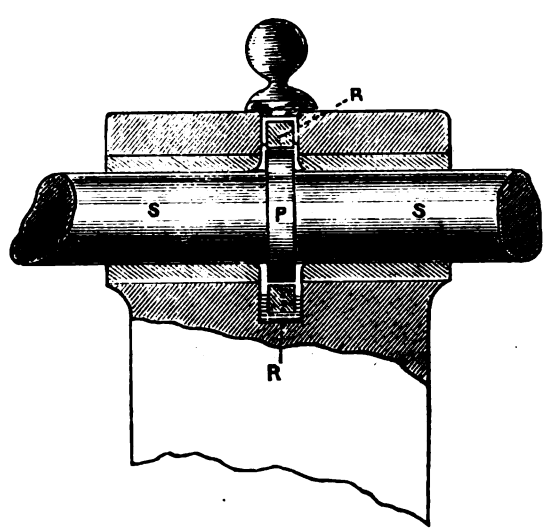

FIG. 1

describing the exhibit of the Brush Company, we give this week a description of a new method of lubricating the dynamo bearings, which somewhat resembles the contrivance adopted by the Edison Company (*The Electrician*, September 6th, p. 446). This device will be understood by reference to the figure. The armature spindle SS (Fig. 1) has a raised collar, P, turned on the spindle. On to this is loosely fitted a ring, R R, which revolves with the spindle and gathers up the oil from the cavity below, and distributes it over the spindle. To facilitate this action, a fork or prong fitted into a wooden handle is put through a hole in the cover and cut out so as to fit round the ring, as shown; it thus keeps the ring in position, and at the same time scrapes or leads off the oil on to the spindle, thus helping it to flow off more readily, the soft metal being grooved in the usual way to allow of free circulation. The company have also introduced one or two alterations in the construction of their well-known arc lamp, which enables it to be used with alternating currents. The transformers which are being used in the stand are connected

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up as follows, for the purpose of obtaining the E.M.F. required by the lamps. For running the arc lamps in parallel the primary coils of two transformers are joined in series, and the secondary coils connected in parallel; for the incandescent circuits the primary coils are joined in parallel to the dynamo terminals, and the secondary coils in parallel also. At the corner of the stand there is a 24-inch projector, as supplied to the navy. The method of driving the dynamo may be noticed as being Raworth's Patent endless rope gear, which consists of one continuous rope with a single joint passing several times round the pulley and driving wheel, the proper tension being maintained by means of an adjustable pulley attached to a bracket fixed to the floor.

Laurence, Paris and Scott.—One of the centres of attraction in the Exhibition is the stand of Messrs. Laurence, Paris and Scott (Limited), of Norwich, where, amongst other things in motion, may be seen the small engine and dynamo shown in Fig. 2. The engine appears to be exceedingly well made, as it runs quite silently at 400 revolutions per minute. It has wide bearings, balanced steel crank-shaft, and Pickering governor, adjustable whilst running. The lubrication is effected, without stopping, through properly arranged oil tubes fed by cotton syphons from ordinary oil boxes. The engine drives, by means of a thin 4½in. leather belt, a small compound-wound 1,250 watt dynamo, fixed on a sliding bed-plate, and running at 1,400 revolutions per minute. Several motors of the same type as this dynamo are shown driving the machinery in motion in various parts of the Exhibition, notably one driving a silk loom, and another in a corner by the entrance to the "Winter Gardens," driving some heavy stamping and piercing machinery. These motors are all shunt-wound, and have in addition a special series-winding outside the shunt. This is only used to start the motor, when it acts as a resistance to the armature circuit and prevents an excessive current, at the same time, exciting the field magnets more quickly and more powerfully than the shunt coils alone would do. As soon as the motor is fairly started, this series winding is cut out by an ingenious magnetic switch, which also automatically introduces the series winding again after the motor has been stopped, and thus prepares for a fresh start. A circular saw bench is exhibited in combination with one of these motors, the motor spindle and the saw spindle being coupled by means of a flanged coupling, and the motor being supported by a bracket attached to the side of the saw bench. A small combination of motor and centrifugal fan on one bed-plate is also shown by this firm. The motor spindle is coupled direct to the fan spindle by a sleeve coupling, and the fan runs at something over 5,000 revolutions per minute. It is intended to furnish the blast for a small forge. Above the door of the adjoining refreshment room may be seen a still smaller motor carrying a ventilating fan, which runs quite silently, although moving a considerable volume of air. A larger ventilating plant is shown in the engine room, also a 9 kilowatt shunt-wound dynamo, and a 12 kilowatt compound-wound dynamo, the first of which supplies current to the Telpher line in the "Winter Gardens," and the second to motors and lamps in various parts of the Exhibition. The series winding in the compound machine consists of two coils, each having 28 turns of sheet copper, 4½in. wide and ·025in. thick. We understand that Messrs. Laurence, Paris and Scott are manufacturing an erg-meter with a very wide range, and we hope shortly to give particulars.

On the next page will be found the list of gold, silver, and bronze medals awarded to the electrical and engineering exhibitors, together with full particulars as to the exhibits for which these awards were made. Eleven gold, 20 silver, 5 bronze, and 7 special gold medals, or 44 awards in all, have been obtained in the electrical section, which comprised about 50 exhibitors.

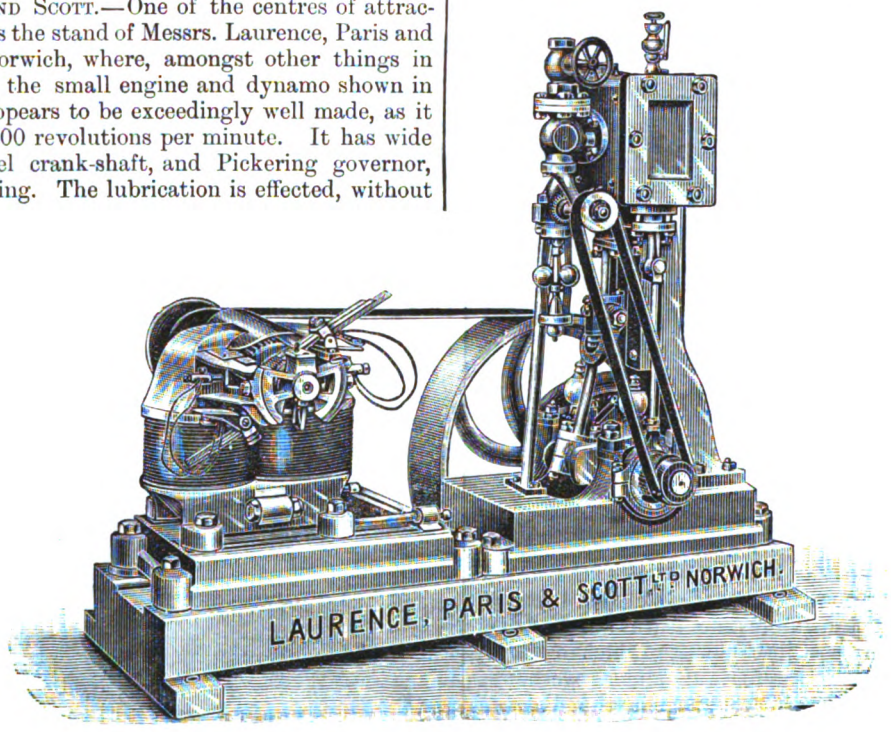

Fig. 2.

We illustrate, in Fig. 3, the design for the medals which have been awarded. The medals are in gold, silver, and bronze, and

Fig. 3.

are from the design submitted by Messrs. Jenkins and Co., Victoria-street, Birmingham. The inner part is enamelled, and the reverse side has the inscription "awarded to," &c., engraved upon it.

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AWARDS.

FIRST-CLASS GOLD MEDALS.—ELECTRICAL SECTION.

Class I.—*Lighting and Power.*

Anglo-American Brush Corporation	Alternating-Current Dynamos and Transformers. Lighting and General Exhibit.
Buller, Jobson and Co.	Insulators.
Crompton and Co. ...	Electric Crane and Incandescent Lighting Dynamos.
Elwell-Parker (Ltd.)..	Accumulators and Incandescent Lighting.
Edison-Swan Co.	Incandescent Lamps.
Goldston, A. A.	Series Arc and Incandescent Lighting and Exhibit.
Lacombe and Co.	Electric Light Carbons.
Laurence, Paris and Scott	Dynamos and Motors.

Class II.—*General.*

Avery, W. and T.....	Electric Weighing Machine and Bells.
Fowler, Lancaster & Co.	Electrical Fittings in China.
Tullis and Son	Orange, Tan, and Link Belting.

FIRST CLASS SILVER MEDALS.

Class I.—*Lighting and Power.*

Acme Electric Works.	Electrical Fittings for Electric Lighting.
Appleton, Burbey and Williamson	Main Switches and General Exhibit.
E.P.S. Company	Storage Cells and Instruments.
Fowler, J., and Co. ...	Lead-covered Cables.
Glover and Co.	Wires and Cables (Lighting and Telephonic).
Henley's Telegraph Co.	Wires and Cables (Submarine).
Immisch and Co.	Motors.
C. Müller	Instruments and Carbons.
Ernest Scott and Co. .	Parallel Arc Lighting.
Statter and Co.....	Constant-Current Dynamos and General Exhibit.
Woodhouse & Rawson	Electrical Apparatus for Lighting.
Campbell Gas Engine Company	Gas Engines.

Class II.—*General.*

Canning and Co.	Electro-plating.
Davis and Sons.....	Outdoor Electric Light Fittings.
General Electric Co ...	General Exhibit.
Middlemore	Belting.
Nalder Brothers	Electrical Instruments.
National Telephone Co	Improvements in Telephone Apparatus.
Piercy and Co.	Griffin Gas Engine.
Julius Sax	Electrical Fire Alarms, &c.

FIRST-CLASS BRONZE MEDALS.

Class II.—*General.*

Coad, T.....	Primary Batteries.
Conradty, C.....	Carbons.
Hartley and Co.	Electro-plating.
Myatt and Pullinger..	Ditto.
Mayfield and Co.	Wimshurst Electrical Machines.

SPECIAL AWARDS.—*Gold Medals.*

Laing, Wharton and Down	Thomson-Houston Electric Arc Lighting System
Robey and Co.	Small High-speed Engine.
Greenwood and Batley	High-speed Armington-Sims Engine.
Ruston, Proctor & Co.	Compound Engine.
Galloways (Limited)...	Boilers.

Silver Medals.

Lloyd & Co.	Mill-Shafting, Bearings, and W.I. Pulleys.
Blackman Vntilatng Co	Air Propellers.

INTERIM REPORT OF THE COMMITTEE ON "CERTAIN MOLECULAR PHENOMENA ASSOCIATED WITH THE MAGNETISATION OF IRON."*

At a meeting of the British Association at Bradford in 1873, a Paper was read by the Secretary of this Committee, and subsequently published in the *Philosophical Magazine* for December, 1873, "On Certain Remarkable Molecular Changes occurring in Iron Wire at a Low Red Heat." In this Paper the phenomenon known as the *recalescence* of iron was first published, it having been discovered by the author early in September, 1873. At the suggestion of the late Prof. Balfour Stewart, a small Committee was appointed, of which Prof. Barrett was appointed secretary, to investigate and report on recalescence and other molecular phenomena attending magnetisation. This committee had some meetings, and a good deal of unpublished experimental work was done by the secretary, but no quite satisfactory explanation of the main point, the phenomenon of recalescence, was arrived at. It was evidently not a surface phenomenon—not a mere effect of conductivity, as had been suggested—but arose from some molecular change in the metal itself. The lamented death of the two principal members of the Committee, Prof. Clerk Maxwell and Prof. Balfour Stewart, left the matter in abeyance, and the Committee lapsed before a report was presented. Recently, however, the Committee has been re-appointed, and now consists of Prof. Fitzgerald, as chairman, Mr. Trouton, Mr. Newall, and Prof. Barrett, as secretary. Owing to various causes, it is not proposed on the present occasion to do more than present a formal interim report, reserving till next year the full report of the Committee.

So much work has of late been done on the general subject of the molecular phenomena attending magnetisation that it would now be beyond the scope of the Committee adequately to report on the whole matter. We propose, therefore, in the first instance to confine our report to those phenomena accompanying the so-called critical temperature of iron—that point in, or near, which the magnetic state is lost in heating and regained on cooling. Here, at a dull red heat, a series of profound and remarkable changes occur in iron and steel, to which attention was called in the Paper referred to above. The principal points in that Paper were as follows:—

"1. Mr. Gore, in 1869, had discovered that a momentary *elongation* of iron occurred in cooling after heating a wire of that metal to a white heat. In 1873 the author found a similar but reverse action took place in *heating* the wire. 2. This anomalous deportment was found, both in heating and cooling, approximately to coincide with, on the one hand, the *loss*, and on the other, with the *resumption* of the magnetic state of iron or steel. 3. At the critical temperature the wire, having cooled down to a dull red heat, suddenly flashed into a bright glow; likewise during the *heating* of the wire the temperature remains stationary for a short time when the critical temperature is reached; a rise in the specific heat of iron and steel, therefore, occurs at the critical temperature. 4. A curious crepitating sound occurs at the critical temperature, similar to that heard in the magnetisation of iron or in the production of the scales of oxide on the wire. 5. Prof. Tait's remarkable thermo-electric change in iron occurs at this same temperature. 6. Hard iron wire and steel wire exhibit recalescence, but certain specimens of good soft iron failed to show it, and even in the wires that exhibit it the phenomenon grows less marked after repeated heating and cooling."

To these observations may be added that a recent investigation by the secretary of the Committee on the properties of 14 per cent. manganese steel wire (*Proc.* Royal Dublin Society, December, 1886) shows that this body, which is almost a non-magnetic metal, does *not* exhibit the anomalous deportment observed in ordinary steel wire. This fact is of considerable interest as linking the foregoing phenomena more closely with the magnetic state of iron and steel.

Estimating the temperature of the critical point approximately from the expansion of platinum brought to the same state of redness, it was found some years ago to be not above 800°C. The recent admirable investigations of this point by Dr. J. Hopkinson has shown it to be 680°C., rising to 712°C. during recalescence. Dr. Hopkinson has also shown that the temperature at which steel ceases to be magnetic is 690°C., so that he has definitely established the important fact of the identity of the two temperatures.

When we remember that the mechanical, electrical, and thermal properties of iron and steel are of the utmost practical importance, and that all these properties appear to undergo a remarkable change at the critical temperature, the need of a searching investigation on the question is obvious. Moreover, the interest is no less, from a theoretical point of view, in connection with theories as to the molecular structure of magnetised iron and steel.

Recalescence being feeble in soft iron, but marked in hard iron and steel, it was conjectured that the phenomenon might be

* Read by Prof. Barrett at the meeting of the British Association at Newcastle-on-Tyne, September, 1889.

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due to an action, depending on the presence of carbon in iron, creating an effect analogous to that observed when water or super-saturated solutions are cooled below the solidifying point, a slight disturbance of the liquid thereupon producing a sort of explosive action, solidification occurring with a sudden rise of temperature. Prof. Roberts-Austen has drawn attention to the fact that lately M. Osmund, in France, has made recalescence the starting point of a new inquiry, tracing the effects of Carbon, Mn, Cr, S, P, and Si, on the points at which recalescence occurs or is destroyed by the alloy; that whilst *pure* iron does undergo a molecular change at a red heat, carbon retains its position as an important factor in determining the point of recalescence in hard iron and steel. Messrs. Barus and Strouhal have recently published in America a series of important Papers on the tempering of steel, and shown that a critical temperature, of between 500° and 1,000°C, exists which is intimately connected with the hardening or annealing of steel. They also draw attention to the numerous phenomena observed to occur at this temperature. Numerous other experimenters have worked at recalescence, notably Mr. Tomlinson, of King's College, and Mr. Newall, at Cambridge, but the bibliography and discussion of the whole subject will be reserved to the report next year.

DISTRIBUTION OF ELECTRICITY IN CHELSEA, &c., WITH ACCUMULATORS AS THE MAIN SOURCE OF SUPPLY.

BY MAJOR-GENERAL WEBBER, C.B.

The following is a full report of the discussion on the Paper read by Major-General Webber at the British Association:—

Mr. W. H. PREECE: I should like to ask General Webber for some further information. I am afraid he rather misled some of us by saying that the cost of feed plant for his system was 40s. per lamp; I think that wants a little modification.

Major-General WEBBER was glad of the opportunity of correcting a misapprehension into which other members of the audience might have fallen. In the estimate of 40s. only the generating and storage plant were included. The other factors differed very much according to circumstances. He thought it would be perfectly fair to say that for the total outlay in the area which he had described—giving the outside figures—about £4. 9s. 6d. should be allowed for a 30-watt lamp.

Prof. FORBES said many would agree with him that General Webber's Paper was one of the most important papers they had had on the subject of the distribution of electricity. It was not a hypothetical paper in any way, but it dealt with what had actually been done by a company, and described the first large scale application of storage batteries of the size in the way mentioned. Everyone must see from the description that had been given in the Paper that every part of the scheme had been thought out with a care which had been by no means common in all the central stations which had been designed on a new plan for the first time. In every department of the scheme, whether in the mains or in the arrangement of the batteries or in the meters, an enormous amount of thought had been put upon the details. One could see that very clearly. Consequently he thought everybody would agree that this was one of the most interesting central stations which had ever been put down, and one which would attract a great deal of attention in the immediate future—to see with what success it works, and how, financially, it comes up to the level of other central stations. There were some details he should like to speak about—not the least with the intention of criticism, but rather to draw attention to points which seemed of general interest. The first point was the system of distribution. So far as he could judge—and of course there were some details it was impossible to judge of from a written Paper—it seemed to be extremely carefully arranged, and to be very thorough indeed. There was only one point about it he did not quite understand. The feeders, charging mains, and distributing conductors were all arranged in what seemed to be an admirable way; and he hoped General Webber had introduced what was certainly a very desirable thing to introduce—varying differences of potential at the charging station of the different feeders. That in a direct system of supply was a most important thing. It also seemed very desirable to introduce counter E.M.F. cells, such as had been introduced here, when dynamos were being used, in order to adjust the pressure in the different feeders. But here he did not see what was the object of introducing counter E.M.F. cells, and perhaps General Webber would explain why he had added counter E.M.F. cells instead of simply supplying the feeders from a lower series in the scale of cells which are ordinarily in use. As to meters, he had better not say much, except that the type General Webber had described was a new modification of a system of which a good many kinds had been made on the same sort of principle; but the new type seemed to be a very ingenious arrangement. The only thing he would suggest was that where people had tried to use electro-magnetic clocks they had generally come to the manual-wound clock in the end; and he thought that in all probability as a matter of expediency that would ultimately be found desirable. On the other hand, at Berlin, where the hand-wound clocks were used very largely, they looked upon that as the chief defect of the Aron meter. One of the most interesting things in the Paper was the system with which General Webber's name was so intimately associated—that was the question of the conduits, which presented many points of interest, and in many ways were extremely convenient. The facility of manufacture was certainly very great, and it was a great thing to have a separate channel for each different conductor. When, however, it was considered that there was no attempt at insulation in the material which formed the conduits, it became a little difficult to see what was their exact object, because if they were not waterproof, and did not act in any way as insulators, their only use apparently could be as a protection for the cables, and the material being friable, and apt to break if dropped, it seemed that steam rollers and pickaxes would be apt to break it. Of course it could be easily mended. He asked whether the only advantage in the system was simply facilitating the drawing in and out of the leads. That was a very great advantage, and one which was far too much overlooked in many conduit systems; and even if that was the only advantage he should still say it was a very great one. After seeing what was being done in London at present in tearing up the streets, and the awful mess the streets were in, it was satisfactory to hear that General Webber thought he could put his thin layers of conductors under the foot pavement, occupying only a few inches of depth. Some system like that would be very largely used in the future. As to bare copper wires, they must all be very much indebted to General Webber for giving his actual experience. It has been very difficult to get actual experience from those who had used them; they were very reticent in giving the facts, even when closely pressed upon the point. The fact that he had been obliged to give this up made one think it was not so good as one had thought. He had always thought it looked very promising indeed. In one section of London where bare copper wires were being laid, they were being laid in troughs in which there were bends in a vertical plane which were not drained at the bottom of the bend. He would draw attention to what was perfectly certain to ensue from that. When water got in, which it was certain to do, it would rise up to the level of the conductors; it must, even trickling in, get decomposed for a certain time until it has decomposed away; and at the moment of breaking the contact a spark will occur and the mixed oxygen and hydrogen will undoubtedly explode. General Webber said he would not deal with financial results in his Paper, but they would all look forward with interest to a subsequent year when he would bring before them a Paper giving some of the results of the financial working, for that was really the point which was of most interest to electricians. He though every one would agree that a storage battery system was better than any other system which had ever been proposed, if the cost of the batteries and of their maintenance were sufficiently reduced. In every other way they would be superior to any system of distribution for a large number of lamps. The only financial result which General Webber had spoken about was what he had mentioned in consequence of Mr. Preece's question. It was a considerable help to be able to take it at about £4. 9s. 6d. for a 10-candle lamp That came out approximately, from comparisons with his own estimates for Paddington and other plans on the same lines for transformer work, to very nearly double what an alternating-current system would be on the whole plant, which came to about £4 or £4. 10s. per lamp of 16 candles, he thought, as a rule. A few words as to Mr. King's system of batteries. He had taken very great interest in them, and had been very pleased to see not only what was done at Colchester, but also what had been done lately at Millwall. He felt confident that Mr. King was right in believing that the whole cause of the failure at Colchester was the badness of the batteries. The batteries were very fairly good ones for that period, but they were not uniform; and it was only by having batteries of extreme uniformity that this system could be applied. The question arose whether in a sub-station where there was a large number of batteries, and where there must be an attendant looking after them—whether that attendant would be able to attend to the ordinary adjustments of pressure, and so forth. The cost of this arrangement with King's system was certainly not large, and it was extremely convenient. He had satisfied himself, not only from what he saw actually at work at Millwall, but by a careful inspection of experimental work of many months, which had been shown to him, that it was a system which would practically work extremely well; therefore if the labourer who is employed at the sub-station could do the work of this mechanism, then simply the cost of the mechanism was well worth the expenditure upon it, because the attendant would never have to supervise the mechanism, and would be relieved from a good deal of the labour.

Prof. EWING asked General Webber whether in practice he found any serious error coming into the readings of the meter he had described on account of the defects of the retentiveness of the iron core which controlled what General Webber called the integrating current. When a strong current had been sent to this meter one would expect that subsequent readings would be unduly large as compared with those readings which followed a weak current, on account of the iron core retaining a portion of its previous magnetisation.

Prof. SILVANUS THOMPSON said the meter which General Webber had described was a very interesting addition to those interesting instruments, and he believed they were all very anxious to know whether it was going to be the practical electric meter of the future. The whole subject of electric meters was one on which a great deal yet remained to be said. There was no one meter yet which had shown itself to be so far superior to the others that they could point to it and say: "That is the right thing in your house for measuring your electric consumption." The difficulty of the varying magnetic qualities of iron seemed to be got over in a most ingenious way by the introduction of the so-called integrating piece, called the cam. He asked General Webber how to find out exactly the proper shape to give that cam—is it done once for all on a certain piece of iron, or is every meter to be separately tested, and a separate cam cut for each?

Mr. W. H. PREECE said there was an immense amount of interest felt in the success or the failure of this system of the distribution of electricity

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by accumulators in Chelsea—principally because the first attempt made at Colchester some years ago was a failure; secondly, because there was a most remarkable and a strange want of confidence in accumulators. He found by experience that those who had no confidence in accumulators were those who had never used them, while those who had used accumulators had very great confidence in them. He, as most of them pretty well knew, had been a staunch advocate of accumulators from their very earliest introduction into this country. Nearly six years ago his house was lighted by accumulators, and they were using them very largely in the Post Office, not only for electric lighting, but for telegraphic purposes. They had three or four hundred circuits which had been working for the last four years from accumulators. They were now introducing them for telephones. His own impression was that it was only a question of time to find the 30,000 cells in use in the Post Office in London replaced by about 300, or perhaps 1,000 accumulators. Hence the experience of accumulators was very much in their favour, and why it was that people still persisted in decrying them he could not make out. One cause was that they had been shamefully ill-used. People when they got batteries fancied that these batteries were going to do a lot for them. A great deal more was drawn out of the batteries than they were intended to give, and a great deal more current was put in them than they ought to receive. But when batteries, when accumulators, are treated fairly and properly, when they are not over-charged and when they are called upon quietly and gently—why the life of a battery is really at the present moment unknown. At the present moment he was not prepared to say that their life was more than equivalent to a renewal of about 15 per cent., but he thought in coming years, with the improvements that would arise, they would find that they would be able to maintain their batteries with probably 10 per cent.—they might even come down to 7½ per cent. of renewal. However, they would watch this experiment in Chelsea with a great deal of interest, and they would look forward at the meeting at Leeds next year to have a report from General Webber of the progress made. There was another point where he thought they would gain a great benefit, and that was from the conduits. There was one immense advantage that General Webber had over most of those electrical engineers who had been carrying out systems of distribution, and that was that he had experience of underground wires, and they had not. He did not know anything where experience was wanted so much as in the work of laying down wires underground and maintaining them. There was a terrible heresy committed in that room by Mr. Killingworth Hedges, who spoke of the relative advantages of underground wires and overground wires. He spoke as though an underground wire gave no insulation whatever, and as though the insulation of an underground system was far inferior to that of an overground system. As a matter of fact the reverse is exactly the case. Underground systems not only give a very much higher insulation, but they do very much more—they give a uniform insulation. From year's end to year's end one could rely upon the insulation of an underground system; while the insulation of an overground system is not only very low, but it is very variable and very troublesome. There was one other heresy—but it was not a heresy, it was rather want of the latest information—on the part of Mr. Hedges. That was the statement that the London Electric Supply Company were going to use mains with one conductor put to earth. Well, that was not true. There was a very delicate system used at the present moment in all our towns, and that was the system of telephone exchanges; and if such a system as that proposed to be laid down between London and Deptford were so constructed that the outside conductor were to earth, it would simply entirely upset the whole of the telephone system in London. They could not allow that, and the Government had been obliged to step in and to say that the outside conductor should not be put to earth, and something else must be provided. The result is that the main which the London Electric Supply Company are going to lay down has the outside conductor very well and very carefully insulated. It is a concentric cable; there is a solid wire in the centre, which is insulated; there is a cylinder of copper outside, which is also insulated. It is a very good conductor as far as the insulation goes, and he hoped it would answer their purposes.

Major-General WEBBER then replied to the discussion: As regarded the introduction and use of the counter E.M.F. cells, he would remind Prof. Forbes that the actual E.M.F. of each set of cells was considerably above the standard of pressure distribution required in the mains, and that these cells were destined, as it were, to control and keep down the excessive pressure acting against it at the commencement of discharge. There was a very considerable margin in having four of them, and probably more than bringing in one or two at any time as the discharge is coming to an end is not likely to occur. The question of the material in use in the conduits is one which is naturally raised, because it is unquestionable that as a material it has the defect of being friable, and that as a protection against injury when any workmen are digging in the same soil, it is not so good as tougher and harder materials. As regards steam rollers in Lennox-gardens, which is one of the squares in which a main is laid down under a Macadam surface road, the steam-roller came into operation immediately after the casing had been laid about 2ft. 6in. below the surface. He had every reason to believe that the men in charge of the steam-roller wished to put the casing to the most severe test they could. Although the earth was still loose in the trench, and although they ran the roller so that the edge of the wheel pressed down that earth and so that the weight of the roller was not distributed by being supported by the virgin earth or the solid earth each side, yet when we dug up that piece of line we found that they had not broken the casing. That was a fair test. There were other objections no doubt to the material—its porosity and its being susceptible to changes of temperature (fortunately, changes which are not very great in our climate). The adoption of the material, he thought, resulted from the effort to find one which would be economical, which could be moulded, as it were, easily, and which would permit the ways varying from three to six to pass through its interior. He saw in a late copy of one of the American papers that the Americans were doing exactly the same thing with some other plastic material; what it was he could not trace, because he had only seen an abstract of the patent. The financial results, which no doubt would be very interesting, and which ought to be perfectly reliable by this time next year, would, he thought, turn out better as to capital expenditure than the conclusion Prof. Forbes drew from the answer extracted from him by Mr. Preece. In making a comparison between two systems, it seemed to him that the only fair comparison could be on the outlay—in the case of such a system as this, on the generating plant and the storage plant, and in the case of any other systems, such as the transformer systems, on the generating plant and the transformers themselves, leaving out all questions of building, exceptional expenditure and distribution. When making that comparison, and putting it in Chelsea at 40s. or 35s., as calculated by the Storage Company for a very much larger one, he thought they would find that it was not a question of double. When he gave the total figure as £4. 9s. 6d. he included the actual figures and the actual amounts spent upon work under novel and exceptional conditions, where a building had to be erected of a much more costly nature than would be naturally the case if it could be avoided, so that he did not consider the £4. 9s. 6d. as being double the figure to be taken. As regarded the attendance at the storage stations, of course, it was quite understood that the automatic regulator is intended to avoid attendance. As to the actual amount of attendance required, it is quite certain that constant attendance while it was in use was not necessary. Their experience was that a well-instructed youth, receiving about 20s. a week, could give all the attendance necessary, not for renewal, but for the actual ordinary maintenance, to three such stations. He quite agreed with Mr. Preece's remarks on the subject of accumulators and their maintenance. He thought there was a very great probability of the actual cost of maintenance before many years being reduced to close upon 7½ per cent., as suggested by Mr. Preece. With respect to the meter, of which he had shown a rough sketch, and which was quite a new apparatus for practical use, up till now they had only placed it alongside of Aron's meter—that is to say, they had not yet entrusted to any one of these meters the sole duty of measuring the current to a customer; but in every case, and there were several, in which one of them had been placed in conjunction with an Aron meter for the purposes of experiment, the results, so far as the record was concerned, were found to be identical. There was no doubt that the residual magnetism in the regulating solenoid or the solenoid which regulates the elevation of the notch in the cam is a condition which will and should exaggerate the record. He was not prepared to say that the Aron did not do the same thing under other conditions, but so far the results had been identical. That also was the case when compared with the Chamberlain and Hookham meter. Therefore, up till now he could not say that there was any danger in using it as against the customer. The shape of the cam was produced first from a theoretical curve, but in practice every one of the cams had to be tested and the notches filed anew, so as to give an accurate result in vacuum. When saying they were all calibrated by altering the notches, that was very easily done. It was a very thin brass plate, and it was very easy to alter the notches both in length and depth by a file, and in that way before being put into use every meter was adjusted and calibrated.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, October 28th.

LONDON CHAMBER OF COMMERCE.

4 p.m. Meeting of the Electrical Trades' Section Committee at Botolph House, Eastcheap.

TUESDAY, October 29th.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture, "Pygmies." By Prof. W. H. FLOWER.

WEDNESDAY, October 30th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary Meeting. Papers to be read: "On the Results of Blast-Furnace Practice with Lime instead of Limestone as Flux." By CHARLES COCHRANE. "Description of a Rotary Machine for Making Block-Bottomed Paper Bags." By JOB DUKRDIN. "Further Experiments on Condensation and Re-Evaporation of Steam in a Jacketed Cylinder." By MAJOR THOMAS ENGLISH, R.E.

THURSDAY, October 31st.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Ordinary Meeting. Papers not read at the previous Meeting.

FRIDAY, November 1st.

PHYSICAL SOCIETY.

5 p.m. "On Electrifications due to the Contact of Gases with Liquids." By J. ENRIGHT. "On a New Electric Radiation Meter." By W. G. GREGORY, M.A. "On a Physical Basis for the Theory of Errors." By C. V. BURTON, D.Sc.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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The Electrician.

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"THE ELECTRICAL WORLD" OF NEW YORK.

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UNDERGROUND CONDUCTORS.

During the last few months any not unobservant stranger meandering about London streets must have had his attention here and there drawn to various operations and excavations in the road or footway, indicating that some process of laying down certain underground structures was in active progress. The daily Press and his own intelligent inquiries will have informed our philosopher that these operations formed the essential steps in the serious undertaking of supplying the Metropolis with distributed electric current for domestic and private electric lighting. The initiated know that these distributing constructions in the public thoroughfares are supplemented by the erection of central stations in various positions, in which the erection of steam-engines, boilers, dynamos and batteries is progressing or completed, and constituting the essential generating plant. The writers of brilliant newspaper articles, the average business man, and even the laboratory scientist, are probably inclined to direct most of their attention and interest to the generating plant. Dynamos with colossal armatures, engines of enormous horse-power, and tiers of boilers have an imposing aspect, whether in print or in reality. The difficulties involved in selecting suitable sites, in the proper design of buildings, in the arrangement of steam power, and in dynamo construction, or even in selection of the appropriate type or system of electric current generation, are serious and not small. The power to deal with these difficulties calls for engineering talent of a high order. Those persons, however,

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who have had the opportunities to become acquainted with the inmost details of these enterprises in many places and under many forms are likely to direct their attention not at all exclusively to the more prominent portion of the work, but to look with a very careful eye, and to ask some very serious questions about that less showy but equally important portion of the work, viz., the distributing conductors. The erection of large steam engines and boilers is a piece of mechanical engineering so thoroughly well understood that, assuming that proper persons have been placed in charge of it, there need be no manner of doubt as to its successful completion. Dynamo building, and all the accessories of generating plant, have been also brought to such a high degree of mechanical excellence that the establishment of successful electric-current generating machinery is one in which there is not much element of uncertainty as to the performance of thoroughly good and solid workmanship when properly installed. This being so, the cautious observer may ask the question whether there is yet left any possibility of further difficulty, any room for a shadow of doubt as to the complete and immediate success of all schemes now to the front and in process of being realised for the continuous, uninterrupted, and absolutely reliable distribution of electric current in the metropolis and elsewhere.

We think that we shall not be misrepresenting the opinion of the most experienced and competent amongst the electrical engineering profession in suggesting that the question of success or failure of central-station electric lighting in its various forms is very closely bound up at the present time with the questions involved in the construction of underground conductor systems. We can take it pretty well for granted that the accumulated experience is sufficiently great to enable competent men to carry through to success many very diverse schemes for central-station generating plant. Can we also assert with equal confidence that the problem of distributing large electric currents by underground-conductors is capable of equally successful solution on a variety of different plans? In raising this question, we have no intention of suggesting that it is not the case, nor of implying that the various proposed modes of dealing with the practical difficulties of underground conductor systems have not each and all peculiar merits which recommend them in particular cases. That on which we do desire to lay stress is that the practical question of laying down in any district a network or system of subterranean insulated conductors, intended to be traversed by electric currents for lighting purposes, is one in which at the present moment there is need for the greatest caution in travelling beyond the actual limits of ascertained success. It is one in which constructions on a large scale, deviating much from that which has already, at great cost, been found to succeed, should be undertaken only after the most elaborate and careful thought. A network of conductors once laid down over an extensive area is not capable of being easily or inexpensively replaced or remodelled. The constructors of a central electric supply station, perhaps, can often more easily remedy errors of judgment in the design of the generating than in that of the distributing plant. If the next few years is to witness the establishment on a large scale of public electric supply there is no manner of doubt that the difficulties which may or will surround this important achievement will turn very largely on the wisdom and experience which are brought to bear on the design of the distributing conductor system.

In looking back at the development of electric lighting during the last ten years, it is most instructive to compare actual experience with the forecasts or expectations of those who were considered at the time to be the greatest experts. We have only to turn back to the scientific evidence given before the House of Commons Electric Lighting Committee, in May and June, 1882, and collate all that was then said about the distribution by underground conductors with subsequent facts, in order to see that not only men trained chiefly in scientific laboratory research, but practical engineers of wide experience, were absolutely unable to foresee, and powerless to anticipate, the actual difficulties awaiting solution before underground conductors could be successfully laid. Let anyone who is sceptical on this matter compare together the statements of experts on this particular point, who were called before the 1879 and 1882 House of Commons Committees on Electric Lighting, with the statements in the discussion on underground conductors which were made at the Chicago Meeting of the National Electric Light Association in 1889. In the one case we had opinions expressed with a high degree of confidence on matters as to which there was absolutely no experience; in the other we have results of experience seven years afterwards, built up on a foundation of frequent and costly failure. What, then, is the impressive lesson to be learnt from all this? Is it not the trite but still absolutely certain one that there is no road to success except that along which we are led by actual experience and in the light of previous failure? In the interests of all concerned with, and whose fortunes are bound up with the success of electric lighting, it is of paramount importance that there should be as few costly and extensive failures as possible in the enterprise of central station electric lighting.

The ground having been cleared of the chief legislative difficulties, and with the experience gained in seven years of practice and invention, the way lies open at the present time for a great extension in this country of that central electric lighting which has already taken place in other lands. But it has to be, above all things, borne steadily in mind that each and all of these enterprises depends absolutely for its financial success, and, therefore, for its continued existence, upon the complete continuity and perfect reliability of its electric current supply. We are anxious, therefore, at this time to impress upon those who are guiding the fortunes of existing central electric station schemes that no precautions are too great and no examination too elaborate in drafting the designs and settling the arrangements of that distributing conductor which is the arterial and venous system of the electric corporation, and is of as vital importance as the central organs themselves.

Has this been done as completely in all the enterprises now in progress as it is possible to do? Have all those who are responsible for the conductor systems now being laid down in London made for themselves that exhaustive and thorough examination of the methods which have succeeded and the methods which have failed as it is their duty to do? If not, then there may be a rude awakening in store which will react unfavourably upon all departments of electric engineering. The experience which has been gained in years of central station work in New York, Chicago, Boston, Milan, Berlin, is not lightly to be set aside. If, for instance, in these places experience has tended rather in the direction that copper rods, highly insulated in steel tubes filled up with a bituminous insulation, or heavily insulated cables laid in asphalte ducts or conduits, has yielded good results, may it not be, to say the least, a somewhat courageous undertaking to deviate entirely from this experience and lay down in the main thoroughfares of West London a system of iron troughs, enclosing copper strip conductors insulated only by air? We do not in any degree desire to pronounce here on the relative value of these methods. There is no reason why a system of air-insulated cables should not prove in the highest degree satisfactory, provided always that the designer of it has held in proper view such possibilities as displacement of the troughing by sinking of the roadway, and

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flooding with water after prolonged rainfall, or sudden thaws after snowfall, when the ground is sodden, and when the street drainage is incapable of dealing with the accumulated water. All that we do assert is, that, in so far as it deviates from that which has been proved to succeed, it is an experiment, and may involve expensive modifications.

The establishment of the electric arterial system of London is an undertaking of considerable magnitude. We are at present in the condition when every tolerably feasible plan is being given a fair field. Each will, however, be judged severely if it is found wanting, and the survival of the fittest is a certain fact. It should be constantly borne in mind that the experience gained either of a method or a material in laying down a few hundred yards of cable is of comparatively small value in dealing with a conductor system with ramifications extending over twenty or thirty miles. And as to duration, an experience even of a year or so of the insulating durability should not be too confidently relied upon when the question at issue is the construction of an insulating system which must be practically permanent. Electric Supply Companies will not be encouraged to be everlastingly digging up the road or footway in their search for "grounds." The process of cutting out a fault or relaying a burnt-out section will necessarily involve some disturbance of public traffic. The ideal system of conductors is one laid in short lengths, each length capable of being perfectly insulated for testing, and so perfectly constructed in itself that a fault or "burn out" is of rare occurrence. We have every confidence that in time this work of electric-conductor laying will approximate to a standard type of work, and that, like the permanent way of a railway, there will be a definite method of going to work, which will embody all the best experience, and from which great deviations will not be made. It will, no doubt, also come to pass that this department of electric engineering will become specialised. There will be men who will particularly devote themselves to the accumulation of special knowledge on this subject, and contractors who will gain special experience in carrying out this work. We do not consider that in large central station work it is a good plan to commit the whole work of design from boilers to conductors to one individual. A method more conducive in the end to permanent success would be to call in the aid of those as technical advisers who have made a special study of each department. The engineer responsible for the engines and boilers is not necessarily the best man to have charge of the design of the distributing system. In railway work the locomotive engineer does not generally combine the functions of engineer of the permanent way, traffic manager, and managing director. In central electric-station work there is the same need for specialised knowledge. Before an electrical engineer undertakes to lay down a conductor system in the streets of the metropolis he ought to have had a personal and practical acquaintance with similar work in every chief city in the world in which it has been successfully laid. He ought to collate this experience, and in the light of it all to embody in his work every element of known success, and eliminate every element of known failure. He ought to take for granted nothing, and to act with the greatest caution in adopting novel methods not yet stamped with the *cachet* of success.

We are about to bury hundreds of tons of copper in the streets of London, and to transmit through them enormous electric currents. The electric engineers of to-day have in this business of constructing an electric-arterial system for great towns a work of as great, if not greater difficulty, than that of erecting the generating plant, and one in which, by the very nature of the case, it is not possible to experiment, except on a scale of twelve inches to the foot

ELECTRICAL TRANSMISSION OF POWER IN MINING OPERATIONS.*

BY ALBION T. SNELL, M.I.E.E.

Normanton Pumping and Hauling Plants.—I will first refer to a small pumping plant erected at St. John's Colliery, Normanton, in August, 1887. Mr. Warrington, of Messrs. Locke and Co., has kindly allowed me to give the following details:—The pump delivered about 39 gallons per minute through 530ft. head. A very complete test of this plant was published in the mining journals about November 18th of the same year. The results obtained were so satisfactory that Messrs. Locke and Co. decided to put down a larger plant, to deliver 120 gallons per minute, through 900ft. of vertical head, and I was entrusted with the design of the machines. This larger plant was started in February of the following year, 1888, and has continued running about 22 hours per day since then. The run now exceeds 18 months, and during that period there have been no breakdowns traceable to the electrical details, all stoppages being due to mechanical defects, incidental generally to the engine or pumps. The plant has been described before, but not in detail. I now propose to give results of tests made by the colliery engineer, Mr. E. Brown, and myself. The engine is of the semi-fixed type, by Robey and Co., of Lincoln. It is compound, and is rated by the makers at 30 nominal horse-power. It has indicated during the past 18 months on an average about 80 horse-power. The dynamo is driven off the fly-wheel by a link belt 14in. wide, curved to fit the pulley. The belt speed is about 2,750ft. per minute. The dynamo is designed to give 600 volts and 70 amperes. The motor is of similar design to the dynamo, but the field magnets are of lighter construction. The pumps are differential, with two 6in. and two 4½in. rams. The suction is made by the two large rams only. On the in-stroke the 6in. rams deliver water partly into the rising main and partly into the small rams. On the out or suction-stroke the 4½in. rams deliver into the column, and so the discharge is fairly continuous. When doing full duty the pumps make 25 revolutions per minute. The rising main is about 450 yards long, and is composed of 4in. cast-iron pipes. An air vessel about 5ft. high is fitted at the lower end, near the delivery clacks. The piping is undoubtedly too small for 120 gallons per minute. It was really designed for a feeder of about 50 gallons. The water travels in the column at about 250ft. per minute, and there is nearly 10 horse-power lost in friction. The heavy loss is against the total efficiency of the plant, and an allowance can be made if anyone thinks proper. The cable is built up of 19 strands of No. 17 B.W.G. copper wire, insulated and lead-covered. It is about 1,000 yards long and has a resistance of about ·5 of an ohm. About one week after the erection, in February, 1887, the electrical quantities for the full load averaged about 65 amperes and 603 volts, with 450 revolutions of the dynamo and 134 revolutions of the engine per minute. The motor runs at about 450 revolutions per minute, and the pumps at 25 revolutions. Under the above conditions the water delivered was measured and found to be between 118 and 120 gallons per minute. The suction has a rise of about 14ft. and the column is 860ft. in vertical height. Thus the theoretical horse-power in the water is about 32. The engine was indicated at the same time and found to be giving 80 horse-power. The efficiency of the system—that is, the ratio between theoretical work in the water and indicated horse-power of engine—was therefore equal to $\frac{32}{80}=40$ per cent. These tests have been repeated from time to time by various gentlemen, and the readings show a gradual decrease of the losses due to friction, particularly in the engine and pumps. A log has been kept, and the daily readings of current show a steady fall. At the last test, Mr. E. Brown found the current had fallen to about 62 amperes, and the engine only indicated about 73 horse-power. The efficiency had thus increased to about 43 per cent. The figures of the test are as follows:—

Work.	Volts on dynamo.	Amperes.	E.H.P. given out by dynamo.	I.H.P. of engine.	Efficiency.
Pumps running 24 revs. and delivering 117 gals. per min., 890 feet high, =31·5 H.P.	605	62	50·2	73·0	$\frac{31·5}{75}=43·1$ %
Columns run off, and suction clack lids open, engine, dynamo, leads, motor, and pumps. (Friction.)	410	27	14·8	28·6	...
Engine, dynamo, leads and motor. (Friction.)	No register.		...	18·4	...
Circuit open, engine and dynamo. (Friction.)	...	...	...	11·7	...
Belt of dynamo and engine only. (Friction.)	...	...	...	6·9	...

* Abstract of a lecture delivered in the Mining School, Wigan, September 28, 1889.

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The percentage of losses, as calculated from the indicator cards, are :—

	H.-P.	Per cent.
Engine friction	= 6·9	= 9·4
Belt and dynamo friction	= 4·8	= 6·5
Leads and motor	= 6·7	= 9·4
Motor, belt, gearing, and pumps empty	= 10·2	= 14·0
Load of 117 galls. through 890ft.	= 31·5	= 43·1
Water friction in pumps and rising mains	= 12·9	= 17·6
	73·0	100

The engine doing above load indicated 73·0 horse-power. The friction of the water in the pumps and rising main is arrived at by subtracting the sum of the theoretical horse-power in the the water delivered, and the total friction, from the total indicated horse-power of the engine ; or $73=(31·5+28·6)-12·9$. This is not quite correct. The friction diagrams are necessarily taken with no load on the pumps, and hence are all slightly lower than is actually the case when the load is on. From the known efficiency of the motor, the loss in the pumps and rising main has been found to be not less than 10 horse-power. The coal consumption of this plant was so much less than that which obtained with the compressed-air plant, formerly used for the same work, that at my suggestion careful tests were made of the air-plant efficiency. The conditions were singularly favourable for comparison. The superseded air engine was still in position, and could be coupled to the same pumps. There were also two sets of compressors—a pair of horizontal compressors 20in. by 4ft., and a large vertical one. These were each put to drive the pumps, but since the pressure obtainable was only sufficient to raise the water about 530ft., the column was tapped at the Stanley Main seam. Tests of the electrical plant delivering to the same place were also made with the following results. The horizontal compressors gave a net result of 12 per cent., and the vertical one gave a little over 14 per cent. ; while the electrical system returned 44·4 per cent. The figures of the latter test are as follows :—

Work.	Volts on dynamo.	Amperes.	E.H.P. given out by dynamo.	I.H.P. of engine.	Efficiency.
Pumps running at 8 revs. and delivering 39 gals. per min. to "Stanley Main," 530 feet, = 6·3 H. P.	171·0 173·4	47·5 47·5	10·9 11·0	14·2	$\frac{6·3}{14·2}=44·4$ %
Pumps at normal speed with suction clack lids open and column run off.	128 127	28·0 26·0	4·82 4·45	6·3	...
Motor and first shaft only running approx. at normal speed.	111 105	20·0 20·0	2·96 2·80	4·8	...
Dynamo running at normal speed with circuit open.	...	...	...	1·715	...

These last tests were all made by the colliery engineer, Mr. E. Brown. The results obtained were so satisfactory that the pumps were at work only a fortnight before Messrs. Locke and Co. gave on order for a duplicate set of electrical plant, intending to use the new machines for both hauling and pumping. The pair of 20in. by 4ft. compressors were removed, and foundations were laid in their place for the two dynamos ; the old air-compressing engines 20·5in. by 4ft. being arranged by suitable gearing to run them. At the same time a set of three-throw rams, 6in. bore by 12in. stroke, were specially designed for dealing with the water. This new plant was nearly all finished and delivered at the colliery by the early part of the present year, but press of circumstances prevented the starting of the engines till late in July. The new dynamo, motor, and pumps show a further decrease of power for the same work. The quantities average about as follows :—Engine, 50 revolutions per minute; dynamo, 480 revolutions per minute, 690 volts, and 59 amperes; motor, 450 revolutions per minute; pumps, 34 revolutions per minute; water delivered about 125 gallons per minute. The arrangement of the motor house is very complete. A main shaft is run through the three houses containing the two pumps and the hauling gear. This shaft is fitted with clutches, so that either motor can be coupled to either of the pumps or the hauling sheaves ; or both motors can be coupled to the shaft, and all or any of the machines attached. It is a most convenient and efficient arrangement, and prevents a trivial accident resulting in a serious stop to the mine. The following are the particulars of the endless rope haulage: — The main or belt rope makes three turns round the main driving sheave, and then, passing round a tightening sheave, is led through a short tunnel to the main road. Here it gives motion to two horizontal sheaves, making about two and a-half turns round each. These sheaves are coupled to two endless ropes by friction cones worked by screw gear. The main rope is kept running at the desired speed, and the two working ropes are started and stopped as necessary. The main rope is one inch in diameter. The working ropes are both three-quarters of an inch. They are all made of crucible steel. The sheaves are all about 4ft. 4in. in diameter over the iron lagging. The coal now delivered is about 400 tons per day of 8 or 10 hours, the "Haighmoor" rope only being used. The motor is running at about half the arranged speed, and is doing less than half its designed output. The "Kirkthorpe" rope will be put on next week. Even with this additional load of some 300 tons per day there is an ample margin for future increase of output. The arrangement could easily deliver 1,000 to 1,200 tons per day if necessary. No difficulty of any kind has been experienced with the hauling details. The ropes work with the regularity of clockwork, maintaining an almost constant speed whatever the load may be. The dynamo and motor are running most satisfactorily ; indeed, without looking at the ammeter it is hardly possible to say whether the working rope is on or not.

Llanerch Colliery Hauling and Pumping Plant.—As an example of electricity applied to drive a single-rope hauling engine, I will refer to a plant at Llanerch Colliery, near Pontypool, Monmouthshire. This plant has now been in use for about four to five months. By the courtesy of the owners, Messrs. Partridge and Jones, I am enabled to give the following particulars :—The dynamo is driven by a horizontal engine with an 18in. cylinder and 3ft. 6in. stroke, making at full speed about 50 revolutions per minute. The steam pressure varies between 60lb. and 50lb. at the main boilers, and the speed is controlled by a Pickering governor. The engine drives a countershaft by a 9in. by ¾in. link belt, and the dynamo is run off this shaft by a similar but lighter belt. Provision is made for running a second dynamo for lighting and other purposes. The engine-house is built with sandstone quarried on the spot. The pit shaft is 250 yards deep, and the motor-house is about 750 yards in-bye on the main in-take. The copper cable is composed of 19 strands of No. 18 B.W.G., insulated and covered with lead. The shaft is rather wet, and the roads are also damp ; but no special trouble has been caused by this. The roofs and sides are not particularly good. The "falls" have caused some trouble with the cable, but it is fully expected that the arrangements now made will meet the case. The motor is coupled to a counter-shaft on the hauling-engine bed by a link-belt. A pinion on this shaft engages a wheel mounted on the drum axis. The drum is thrown out of gear by a lever to let down the empties, as is usual with single-rope haulage. In fact, the haulage engine is an old-type machine, previously driven by a single engine, and converted for its present use by the removal of the crank shaft and cylinder. The rope is steel, and is ¾in. in diameter. Two drifts are worked. One with a grade of 1 : 8 : the other about 1 : 12. They are both at present some 300 yards long, but will increase in length as the "face" recedes. The trams used are built entirely of iron. They average about 7cwt. empty, and carry about 22cwt. of coal ; so that each loaded tram represents a rolling load of about 29cwt. The wheels are 12in. in diameter, and each pair is keyed to the axle. The rails are of the girder type, and weigh about 28lb. per yard. The general condition of the road is well up to the average of colliery practice. The rolling friction, as measured by a dynamometer, on a level part of the road averages nearly 70lb. per ton. The drift with the 1 : 8 grade has two "partings" in continual use at present, and hence there is a great deal of shunting, stopping, and starting. The signals are given by a "rapper" and the motor is controlled by a lever similar to the regulator in ordinary use on steam engines. The notches correspond to different rates of motor power and speed. The trams can thus be moved a few inches at a time if necessary, and the speed can be varied from a foot per second to the desired maximum. An ammeter is placed in the circuit near the lever so that the brakesman can tell the number of trams on the rope and can also judge whether it is going right with the "journey." If, for instance, a tram leaves the metals, the ammeter needle registers more than the maximum current for the full load ; the driver at once stops the motor and brakes the drum. The tram is then set right, probably before any damage is done. The power absorbed by the drum and rope averages about 5 horse-power. The various horse-powers, speeds, strain on ropes, &c., corresponding to rolling loads of from one to six full trams, are given in the Table on following page, calculated from actual tests. The ohmic resistance of the cable is 1·25 ohms, and the energy lost for the different loads is shown in the Tables. The engine has not been indicated, and so the efficiencies can only be calculated between the outputs of the dynamo and the actual work on the rope. It will be seen that the electrical losses are small. The heaviest loss is that incurred by the friction of the drum and rope. This could probably be reduced by designing special gearing. Accepting things as they are, the efficiency between the maximum work on the rope and the probable indicated horse-power of engine is about 50 per cent. The strain on the rope on the 1 : 8 grade was measured by a dynamometer, and the result averaged for one and two tram readings. It is fairly represented by a pull of 4·5 cwt. per tram. Taking the grade as 1 : 8, the resistance due to gravity is 280lb. per ton. The average resistance measured by dynamometer on the

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No. of Trams.	1	2	3	4	5	6
Weight of trams	29 cwt	58 cwt.	87 cwt.	116 cwt.	145 cwt.	174 cwt.
Pull on rope to draw trams	4·5 „	9·0 „	13·5 „	18 „	22·5 „	27 „
Pull on rope to overcome friction	98 lbs.	196 lbs.	294 lbs.	392 lbs.	490 lbs.	588 lbs.
Current to run rope with trams	20·5 amps.	26 amps.	31·5 amps.	37 amps.	42·5 amps.	48 amps.
E.M.F. at motor	390 volts	430 volts.	450 volts.	465 volts	465 volts	460 volts
Speed of trams in miles per hour	3·72	3·44	3·3	3	2·87	2·7
Horse-power required to run trams at this speed	4·95	9·13	13·03	15·98	19·03	22·29
Estimated horse-power supplied to motor	10·72	15	19	23·01	26·5	29·6
Horse-power lost in motor	·75	1·26	1·76	2·44	3·22	4·17
Horse-power lost in leads	·7	1·15	1·7	2·2	3·02	3·86
No. of revolutions of engine per minute	58	58	57	56	54	52
E.M.F. at dynamo	416	463	490	511	518	520
Horse-power lost in dynamo	·84	1·4	1·98	2·75	3·63	4·69
Estimated horse-power given out by dynamo	11·42	16·14	20·69	25·21	29·51	33·46
Horse-power given out by motor	9·97	13·74	17·24	20·57	23·28	25·43
Ratio between horse-power given out by motor and estimated horse-power given out by dynamo	87·5 per cent.	85·5 per cent.	83·5 per cent.	82 per cent.	79 per cent.	76·5 per cent.
Ratio between horse-power in rope and estimated horse-power in dynamo	43·2 per cent.	56·6 per cent.	63 per cent.	63·5 per cent.	64·5 per cent.	67 per cent.

level was 70lb. per ton. These figures show on inspection the high efficiency that a properly designed electrical plant is capable of. If we take the dynamo conversion at 85 per cent. and the engine efficiency at the same figure, the total efficiency for six trams (*i.e.*, the ratio between work in the rope and the indicated horse-power of engine) will be equal to 67 by ·85 by ·85=48·5 per cent. The motor is also arranged to run a set of three-throw pumps. When these are running, the hauling drum is thrown out of gear.

Andrew's House Pumping Plant.—As a good sample of dip pumping by electricity, I will refer to a small plant erected at Andrew's House Pit, for Messrs. Bowers and Partners. I am enabled to give these details by the courtesy of the manager, Mr. Berkley, junior. The plant comprises two sets of three-throw pumps, with suitable dynamo, &c., and is designed to cope with two small feeders, one about a mile in-bye, and the other rather more. The water was previously raised by two "cranks," each equipped by eight horses, working in pairs for three-hour shifts. The engine has a horizontal cylinder 12in. by 24in., and runs at about 38 revolutions per minute. The steam is controlled by a governor working on a throttle valve. The dynamo is shunt-wound, and gives about 270 volts and 18·5 amperes. The positive cable, about a mile long, is composed of a strand of seven No. 18 B.W.G. copper wires, insulated and lead covered; the *return* is made by an old iron rope about an inch in diameter, laid along the side of the road. The resistance of the entire cable is about 4·5 ohms. Both the motors are fitted with suitable starting and stopping gear, and are independent of each other, so that both or either pump can be run at pleasure. The delivery pipes are about 750 yards long. The quantity of water now being pumped by the two motors is about 60 gallons per minute. The lift from end to end is 44ft.; but owing to friction, &c., the effective resistance is equal to a head of certainly 60ft. The pumps are three-throw rams, 3in. by 7½in. The speed averages 60 revolutions per minute. The plant is a very small one, but is probably the most efficient that could be used under the given conditions. It is interesting, particularly on account of the distance through which the power is conveyed under ground. One motor has been running since Whitsuntide, the other a shorter time. The plant continues to give satisfaction.

Linlithgow Pumping Plant.—Another illustration of the application of electricity to transmitting energy through a long distance is a small pumping plant at the Linlithgow Shale Oil Works, Linlithgow. In this case one of the main engines at the Shale Mine Bank was used to drive a 4 to 5 horse-power dynamo, in addition to its regular work. The electricity thus generated was carried by a bare copper cable carried upon insulators on poles to an old quarry about one and a-quarter miles distant. The wire is No. 10 B.W.G., the current about 10 to 12 amperes, and the tension at the dynamo terminals some 300 volts. At the quarry a motor is geared to a double-acting pump, with a 2½in. bore and a 2ft. stroke. The water is raised through about 600 yards of 2in. pipe, with a vertical rise of 135ft., and is stored in a reservoir. The pumps at 40 revolutions per minute deliver about 33 gallons. The pump house is visited about once a day for lubricating and inspecting the machinery; no further attendance is required. The condition of the pumps and their rate of delivery can be told by simply inspecting the ammeter and voltmeter in the engine-room. The resistance of the cable, four thousand yards of No. 10 B.W.G., is about 7 ohms; and the loss in it averages about 1 horse-power. The main engine is not appreciably affected by the small load, and the cost of maintenance is practically nothing beyond the wear of the plant. By no other means could the same work be done so cheaply and easily. The plant has now been running for about nine months. Mr. Hamilton, the manager of the shale mine, is thoroughly satisfied with the work done, and reports a considerable saving over the estimated cost of the various alternative schemes proposed at the time of ordering the electric plant. These plants have been selected from amongst the most recent installations carried out by Messrs. Immisch and Co. They are typical of work obtained in mining, and show the means adapted to suit electrical plant to the everyday requirements of the coal pit.

THE SLATTERY ELECTRIC METER.

We illustrate this week, from the *Electrical Review* of New York, the Slattery meter, manufactured by the Fort Wayne Electric Company. The readings are direct, in lamp-hours or ampere-hours, as desired, and are said to be almost absolutely proportional throughout the whole range of the instrument.

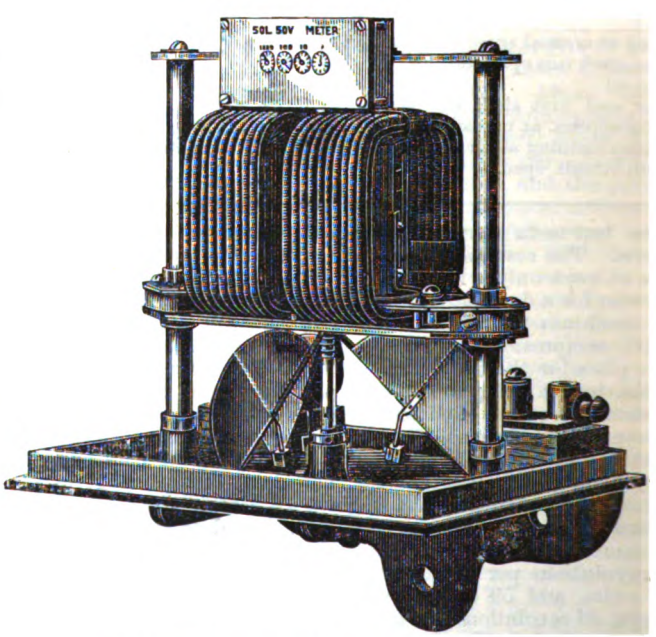

Fig 1.—The Slattery Alternate Current Meter.

The general principle of this motor-meter is the combination of two angularly disposed coils carrying primary and secondary alternating currents, with a movable portion or armature consisting of a very light cylinder of copper, the field of force resulting from the lag of phase as between the two coils. The small amount of inertia possessed by this cylinder permits it to start with a load as low as one 50-watt lamp. The secondary coil is naturally of low resistance, and one form is very quickly and conveniently made by nearly dividing a polygonal shell of copper by saw cuts into parallel sections, leaving, however, a mid-rib to support the sections. By this means coolness, and

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the prevention of eddy currents, are obtained. The loss of energy in this meter is small. The sensitiveness of the meter may be increased by the addition to the copper cylinder of very light iron discs attached to its periphery in planes normal to the axis, though these are not essential.

An ingenious method is adopted to make the rotation proportional to the current. In electric motors in general the speed of rotation increases practically as the square of the current. For meter work retarding vanes are often adopted to reduce the speed for convenience of registering, but the atmospheric resistance of such vanes does not follow precisely the same law, since the retarding effect finally becomes proportional to a higher power than the square of the speed. In the Slattery meter, however, the vanes are constructed with jack-knife blades, which close on the vanes as the speed increases, thus reducing the exposed surface, and allowing the speed to increase to the proper extent. The relations are such that the rate of increase of speed exactly accords with that of the current, and great accuracy is thus attained.

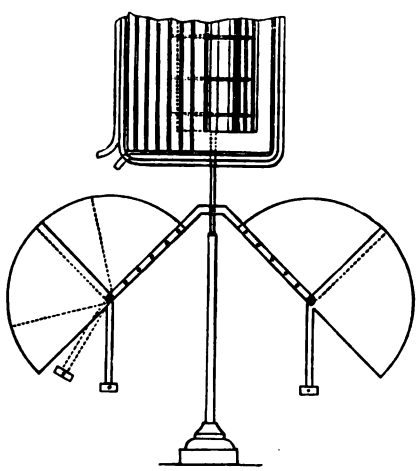

FIG. 2.—Slattery Meter—Outline of Vanes.

In Fig. 1 we have a general view of the complete meter, with its cover removed. In Fig. 2 we have a simple outline elevation showing the arrangement of the vanes for automatic adjustment of their exposed surface. As the speed rises the centrifugal force causes the pivoted outer blades to swing back and overlap the inner blades, thus reducing the surface.

THE LIGHTING OF THE CITY.

SPECIAL MEETING OF THE COMMISSIONERS OF SEWERS.

A special meeting of the Commission of Sewers was held at the Guildhall on Monday, to consider the question of electric lighting in the City, and to resume the debate on the report of the Streets Committee, which had in the meantime been printed and circulated. The report of the Streets Committee was briefly as follows:—Advertisements having been issued, tenders were received on May 10th last from the Anglo-American Brush Electric Light Corporation, for the west and central districts; the House-to-House Electric Light Supply Company, for the eastern district; the Metropolitan Electric Supply Company, for the western district; the Laing, Wharton and Down Construction Syndicate, east district; the London Electric Supply Corporation, all three districts. The Commissioners have since received notices from the Anglo-American Brush Electric Light Corporation, Metropolitan Electric Supply Company, London Electric Supply Corporation, the Laing, Wharton and Down Construction Syndicate, that they will in the next Session apply for Provisional Orders to supply electricity within the City of London. On carefully considering the tenders sent in, together with the suggestions of the companies in regard to conditions, it was found that the tender of the Anglo-American Brush Corporation was the only one practically in accordance with the specification, and under the advice of Mr. Preece, we instructed the officers to negotiate further with the Metropolitan Electric Supply Company and the London Electric Supply Corporation with a view to arrange similar terms with them. This has since been done, with the result that they have severally modified the terms of their tenders, so as to bring them into uniformity with that of the Anglo-American Brush Corporation, and broadly, all these three companies now agree to accept the terms of the original specification, modified only in terms of the Provisional Orders now sanctioned by the House of Commons. The prices per annum per arc lamp are as follows:—London Electric Supply Corporation, £24. 3s. 10d.; Metropolitan Electric Supply Company, £26; Anglo-American Brush Corporation, £26. The first-named company having agreed to waive the condition as to extinguishing half the lamps at midnight, say the price is to be £26 per lamp. After full consideration, we beg to recommend that the tenders of the said three companies be provisionally accepted, subject to their agreeing to enter into a contract for 21 years, determinable by either party at the end seven or 14 years. All the companies agree to make the contract for public lighting determinable at the end of seven, 14, or 21 years. That the three districts into which the City is divided for this purpose be allotted as follows, viz.:—No. 1, West, to the Metropolitan Electric Supply Company. No. 2, Central, to the Anglo-American Brush Company. No. 3, East, to the London Electric Supply Corporation. To light the main thoroughfares by means of 395 arc lamps will cost £10,024, in place of 1,730 gas lamps, now costing £5,530 per annum, but whilst the price will not be double that of gas, the amount of light will be many times greater.

At the suggestion of the CHAIRMAN, the discussion was taken *de novo*, and the Chairman formally moved the adoption of the report.

Mr. SLY, referring to the paragraph of the report in which the amount of electric light is spoken of as being many times greater than that of gas, said this was cleverly, if not artfully, drawn. The word "many" might mean ten times or five times greater. They ought to know what the difference would be. If it was six times, or even three times the amount of light, they did not want it. It was a grave question whether they wanted twice the amount of light in the City. Might they not have 500 candle-power at something like half price? The cost of lighting the whole City at the present time was £11,000, and if they doubled that it would be £22,000. They ought to have been told fully what this interesting experiment was going to cost. He presumed there would be some expense connected with pulling up the streets which had not been allowed for. They might have to go to arbitration, which would involve further expense. He did not think there had been a strongly-expressed desire for electric light in the City, and he submitted that they were not behind other places.

Mr. PANNELL deprecated at this particular time discussing the whole question of electric lighting over again. He took it that the Commission had virtually decided the general question, and what they had before them was the report of the Committee. He was going to move that the report be referred back for reconsideration, which was what the Committee really required. The Committee wished to take the Commission into their confidence at this point, and submitted details as far as they had gone. The Anglo-American Brush Corporation had come on to a common platform with the Commission some time ago, but the other two companies had not come to the same agreement for tendering. There was a requisition for certain information which two of the companies did not give. The Committee said:—"The contractor must give a complete description of the lamps proposed to be used, of the power in watts they consume, and of the light in candles they emit, both of the arc and the glow lamps. The lamps must be so placed that the light distributed over the public ways shall be as uniform as possible, and those tendering will have to demonstrate upon a plan and section, which is to be sent in with the tender, the relative intensity of this distribution of the electric and gas light. The standard of reference will be the illumination of a square foot of surface by a standard candle at 12·7 inches distance." The London Electric Supply Corporation gave certain information, and then said the lamps should be "of the description most suitable to their respective purposes, and the best procurable at the time of installation." That was sufficiently vague. He did not think they could deal with a company that made such an indefinite reply. The Anglo-American Brush Company gave the date when they would commence to light the thoroughfares as required by the Commission; but the London Electric Supply Corporation said "as soon as possible after statutory powers are granted." This company also would only undertake to keep in repair such standards as were erected by them. They would be prepared to utilise such existing standards as might be suitable for their purpose, but they would not be inclined to repair, paint, and maintain them. As regarded price, whilst the other companies stated their price plainly, the London Electric Supply referred to the Provisional Order. This company at the expiration of seven years could give notice to terminate the contract as regarded public lighting and continue to have facilities for private lighting in the district. The Metropolitan Supply Company would charge 6s. 8d. per unit, which was equivalent to 8d. per Board of Trade unit. This was for private

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lighting, but the price for the public lighting would be 3d. a unit. Supposing the company said at the end of seven years, "We are not going to continue the public lighting at 3d.; we will give notice to determine that contract, but we shall have power to continue the private lighting at 8d." Mr. Pannell proceeded to show that the London Electric Supply Corporation gave unsatisfactory answers to other questions. It was just possible they might accept the terms agreed to by the other companies. His object was not in any way to delay the question of electric lighting, but rather to speed it.

Mr. C. T. HARRIS contended that the Committee recommended the Commission to accept tenders on totally different lines from those agreed to by the Commission. The sliding scale was swept away altogether. No arrangement was made for the payment for gas by the contractors during failures, which was always an important item. None of the three schemes agreed, but they were entirely different. He thought they ought at least to have something like uniformity. He was not quite certain that the Brush Company was in a condition to undertake work of a large character like this. He greatly objected to the mode of lighting. To replace 1,730 lights by 395 was a policy of suicide. The Committee had not said how many times greater would be the light, because they could not. It was never the same two seconds together. Mr. Preece had consistently told them that the arc light was not suited for street purposes, and their engineer had always consistently and persistently told them that they must not diminish the number of lights in the City. They wanted diffusion instead of extreme concentration. He reckoned, with all the necessary additions, the cost would be about £13,000, and they would get a much better lighting if they would only turn their attention to improved gas burners.

Mr. INNES said it was with deep regret that he came to the conclusion, as a man of business, that the report must go back. He desired to have electric light on as reasonable terms as possible. It was perfectly obvious they could not accept the terms of the London Electric Supply Company.

Mr. Deputy BEDFORD said if they were going to wait for all possible improvements they would have to wait a long time. He was in favour of having what they could get now. The matter had been referred to their engineer and one of their ablest electricians, Mr. Preece, and they said, "Adopt this report." Let them take a good step forward.

Mr. Alderman MOORE was deeply disappointed that they could not accept the report. He thought the Commission would be very nearly justified in accepting the Anglo-American Brush Company's tender, and their object in sending the report back was to bring the terms of the other companies into conformity with that. They ought to have a larger number of arc lamps so as to have a much better diffusion of light. With these modifications, he thought they might pass the Brush Company's tender at the next Court.

Mr. SHAW thought they ought to have had a much simpler report presented in terms as short as possible. He wished to give the electric lighting companies as much encouragement as possible to carry out the work, but they must carefully consider the conditions under which they are to act. If there was a possibility of getting this light at anything like the price of gas, they ought to have further inquiry. It was only within the last two or three weeks that a new economical system was brought to his notice; a system which could be worked without a dynamo. They wanted to have not only a success, but an economical success.

Mr. DAY (Chairman of the Streets Committee) in replying to questions, said the amount of the electric light would be from four to six times that of gas. It was not quite clear what the Commission wished the Committee to do in sending back the report. Various objections had been raised, but they had not been put in a concrete form.

The amendment was carried by a large majority, and the report was referred back.

The Commission then adjourned.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 12, 1889.

A very important decision, of which you probably have already heard by cable (*Electrician*, October 18th), has just been rendered in the electric light field. It is early yet to determine just exactly its scope and effect, but there is no reason to doubt that it will have a material influence on the future of the incandescent lamp. The case is that of the Consolidated Electric Light Company against the McKeesport, Pa., local Edison Company, for infringement, and is practically one between the Westinghouse and Edison interests, since the Sawyer-Man patent involved is now owned by the Westinghouse Company, while the Edison parent Company has naturally taken up this suit in protection of its local representative. The suit was brought on the patent granted in 1885, after considerable controversy and delay in the Patent Office, for a fibrous filament lamp, the main claim of the patent being for "An incandescing conductor for an electric lamp of carbonised fibrous or textile material, and of an arch or horse-shoe shape." The case was heard before Judge Bradley, of the United States Supreme Court, in the United States Circuit Court for the Western District of Pennsylvania, at Pittsburgh. Judge Bradley, in his decision, goes very thoroughly into the points at issue, and after narrowing the patentable features down to the conductor of carbon made of fibrous or textile material, he has declared that such a patent is invalid. He holds, again, that there was no patentability in combining such a conductor with a glass chamber, nor in giving the conductor an arched shape. These features were old in the art, and furnished no good ground for a patent. Coming to the question whether the patent could be sustained on the fibrous filament conductor itself, Judge Bradley declares that this again is nothing new. Long prior to 1878, he says, it was a well-known fact in science and the arts that the transmission of the electrical current through a pencil of charcoal interposed in a metallic circuit would produce intense light, and that when this charcoal was guarded from the air by being placed in vacuum it could not be consumed. "We are clearly of opinion," he says, "that neither Sawyer and Man nor Edison can maintain any just claim to the exclusive use of charcoal generally in any form as an incandescing conductor in an electric lamp." This view of the case would be sufficient in itself to invalidate the patent, but Judge Bradley dives into the evidence, and brings forward data from it to show that in their original application Sawyer and Man had no such idea in view as that of claiming broadly all carbon made from fibrous or textile material as a conductor in incandescent lamps. Their original intention, he says, as clearly revealed by the evidence, was to secure a patent on the carbon arch. Finding that this was untenable, the original application was from time to time amended so as to embody the fibrous carbon filament matter as a broad principle. Judge Bradley says, however, that he is not at all satisfied that Sawyer and Man ever made and reduced to practical application any such invention as is set forth and claimed in the patent in suit. In fact, said Judge Bradley, Sawyer and Man were following the wrong principle, as many another had done before them, and seeking to secure the practical commercial incandescent lamp by adopting a filament of small resistance with a strong current, whereas the great discovery in the art was that of adopting high resistance in the conductor with a small illuminating surface and a corresponding diminution in the strength of the current required. "This was accomplished by Edison in his filamental thread-like conductors, rendered practicable by the perfection of the vacuum in the globe of the lamp." Judge Bradley then goes on to quote largely from Mr. Edison's patents, showing the evolution in them of this idea of the filament of high resistance, and says, after doing so, "We think we are not mistaken in saying that but for this discovery electric lighting would never have become a fact. We have supposed it to be the discovery of Edison, because he had a patent for it. This may not be the case; it may be the discovery of some other person. But whoever discovered it, it is undoubtedly the great discovery in the art of practical lighting by electricity." This is practically the gist of this decision, which runs a length of from eight to ten thousand words, and which invalidates the patent upon which, had they been successful in sustaining it, the Westinghouse Company could have maintained a monopoly of all fibrous filament lamps It will be seen that the controversy in its legal aspects, even should this decision be appealed, as it may be, narrows itself down to the validity of lamps of high resistance, in regard to which the work of Mr. Edison seems likely to withstand well nigh every attack. The Edison people, therefore, although Judge Bradley denies to them, equally with Sawyer and Man, the peculiar right to the fibrous filament, are inclined to look upon this decision as so much in their favour as to give them the monopoly which the Westinghouse Company proposed to

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secure for itself. Time and further litigation alone can show how this will be, and it is of course to be borne in mind that Mr. Edison's patents so far are liable to forfeiture by the interpretations which have been made of the statutes referring to the expiration of the United States patents on account of the expiration of similar foreign patents. It is urged that Mr. Edison would not have been so anxious to upset the decision against him in Canada unless he had felt his interests in the United States to be imperilled by them. Still, as matters stand at the present moment, the position of the Edison Company is appreciably stronger than it was, and no doubt the most will be made of it. It is somewhat of an odd coincidence worthy of note that Judge Bradley's decision, strongly against the Sawyer-Man's claims, came the same week as Mr. F. L. Pope's interesting book was published on the evolution of the incandescent lamp, attributing to Sawyer and Man the glory and the merit of doing just what we are now told by that high authority they did not do. I do not suppose that Mr. Pope will call in his book, but had he known what was coming he probably would have published it before, or never at all.

As might be expected, the Westinghouse and Edison people have been exchanging compliments over the situation, and these furnish amusing, if not instructive, reading to the public. Mr. Westinghouse claims that the business and profits of his company will not be affected materially by this decision, but that, on the contrary, if the impression gets abroad that the incandescent lamp has become public property, the demands for electric lighting will be increased, and his company will come in for its share. Mr. Edison, who returned from Europe the very day after the decision in his favour had been rendered, was naturally well pleased at it, but could not refrain from saying that Mr. George Westinghouse was once a pretty good sort of a fellow, but had stolen some fifty of his patents, and degenerated into a mere "shyster." There is some curiosity in electrical circles to know just how the Thomson Houston Company, which manufactures its incandescent lamps under the Sawyer-Man license, will act in the circumstances, and just what effect it will have on the business in general. During the past few months there has been talk from time to time of a closer *rapprochement* between these various companies, but it would hardly seem likely, for the present at least, that any drawing together on terms of amity can well take place.

As your readers are perhaps already aware, a decision in the Kemmler case, involving the constitutionality of the New York State law providing for electrical executions (*Electrician*, October 11th), has at last been handed down. The decision is that of one of the county judges, but is none the less important for that. County Judge Day, on the habeas corpus proceeding to test the constitutionality of the law, decides that the law is constitutional, and he has remanded the prisoner to the custody of the warden of Auburn prison for the execution of the sentence. Besides dealing with the constitutional points involved, which are not likely to be of interest to the electrical reader, Judge Day asks whether in this case it has been plainly and beyond doubt established that electricity as a death dealing agent is likely to prove less quick and sure or more painful than the rope. He answers his own question in the negative, and says that before the statute can rightly be abrogated there should be positive judicial knowledge that the punishment provided is actually cruel and unusual. There is no such knowledge, Judge Day holds, and, therefore, the contention of Kemmler's counsel fails. Mr. Bourke Cockran, the counsel in question, says that he expected such a decision, it being hardly likely that a county judge would take upon himself the responsibility of upsetting the law. Mr. Cockran, therefore, will now appeal to the General Term and to the Court of Appeals.

The International Marine Conference, which begins at Washington next week, on the 16th inst., is one in which England is greatly interested. This conference will include representatives from all the great nations and maritime powers with the exception of Portugal. The gentlemen representing Great Britain are Mr. C. Hall, M.P.; Mr. Thomas Grey, Secretary of the Board of Trade; Captain Wyatt, of the Peninsular and Oriental Steamship Company; Captain Kendall, of the Dublin Steamship Company; and Admirals Molyneux, Smith and Nares. Some thirteen main subjects of discussion will be brought before this body, and several of them are of interest to electricians, especially those which deal with lights and signals afloat, and with lighthouses and the patroling of seaboards. Such a Conference will, undoubtedly, do much to simplify and render uniform the lights and signals of the different nations, and in so doing may be expected to favour and recommend for general adoption the various electrical devices that have been found practicable and successful in the different navies and large steamship lines. It is interesting to note, for example, that two vessels of our navy—the "York Town" and the "Dispatch"—have for some time past been experimenting at Newport on running lights and sound signals, and that a report will be presented for the consideration of the Conference. Apart from the question of lights and sounds, there is great interest attaching to the question of saving life and property from shipwreck, and I should not be surprised if attention is drawn to the results obtained in England in connecting light-ships with the mainland for telegraphic and telephonic purposes.

CORRESPONDENCE.

THE PRACTICAL UNIT OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Glazebrook ends his letter in your issue of last week, "Prof. Ayrton graduates his voltmeters in legal volts. Let me ask him to graduate his new standards of electromagnetic induction in 'legal quadrants.'"

May I ask what is a "legal quadrant?" I understand what a B. A. quadrant (query "illegal" quadrant) is, viz., 10^9 C.-G.-S. units of induction. But what is this "legal quadrant?" Is it a secohm? If so, why not call it a secohm, seeing that some thousands of coefficients of induction have already been measured in secohms, and that the name "secohm" is short and correct, while the name "legal quadrant" would be as wrong as it is long? To call a secohm a "legal quadrant" would, in fact, remind one of the schoolboy's definition of a crab—a red fish that walks backwards—for a secohm is not a quadrant, and, like the commercial ohm, has nothing legal about it. I do not know whether Mr. Glazebrook is aware that in communications to Government departments the expression "legal ohm" has been found not permissible, as the eye of the law has as yet taken no cognisance of that unit. And just as, in spite of my great admiration for the splendid work done in the past by the B. A. Electrical Standards Committee, I have always thought they made a mistake in calling their system of relative ideal units "absolute," so I venture to think that the Committee are now making a similar mistake in calling their commercial system of units "legal."

But perhaps, as the Paris Electrical Congress have stated in their resolution that a secohm is 10^9 C.-G.-S. units of induction, which it certainly is not, it is possible that Mr. Glazebrook's "legal quadrant" is not a secohm. If so, will he kindly give us an *exact* definition of a "legal quadrant," not, of course, in terms of a second and a commercial ohm, for, according to Mr. Glazebrook's view, "the coefficient of induction is necessarily the more fundamental quantity of the two." His statement that the "legal unit of electro-magnetic measure is somewhere about $\cdot 99777 \times 10^9$ centimetres," is, of course, not intended to be a definition any more than the statement that an English yard was somewhere about a certain fraction of a metre would be a definition of a yard.

If the name "effective current" is to be given to the square root of the mean square of a current, I should like to ask, while on the subject of nomenclature, what the square root of the mean square of a current is to be called when it is *not* the effective current, as in the case of an alternate-current permanent magnet motor?—Yours, &c., W. E. AYRTON.

THE PRACTICAL UNIT OF SELF-INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue two letters appear discussing reasons for and against the exchange of the names secohm and quadrant. The word *secohm* seems to me much to be preferred, be-

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cause it is simpler and more expressive. The unit of self-induction depends on the *second* and the *ohm* in exactly the same way as the *foot-pound*; the unit of work depends on the *foot* and the *pound*. In fact, most of the methods of measuring self-induction give it directly as the product of a time and a resistance. The name secohm was a suggestion from this college, where a very large number of induction measurements have been made, and it had already come into general use.

Mr. Glazebrook says that it was felt "desirable to emphasise the fact that the self-induction of a coil in electro-magnetic measure was a quantity which could be determined with a metre scale, or something equivalent to such a scale." This is only true, however, in a specified medium. If the coil is taken into another atmosphere its self-induction is changed, although its size is unchanged. The self-induction, if measured in *quadrants*, would be unaltered, but if experimentally determined in *secohms* would be found to be changed. The latter unit must, therefore, be the true one, for everyone knows that the self-induction of a coil is increased if iron is brought near it.

Prof. Rücker has pointed out that the dimensions of permeability and specific inductive capacity have been suppressed simply because they are unknown. The electro-magnetic and electrostatic units appear in consequence to differ in dimensions, although a unit of electricity must necessarily be the same kind of quantity, however it is measured. This inconsistency causes a great deal of quite unnecessary difficulty to students, and I think it tends to retard the progress of Maxwell's theory of electricity by making it appear unintelligible.—Yours, &c.,

Central Institution, October 24, 1889. W. E. Sumpner.

THE PATTEN ALTERNATING-CURRENT MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The Paper by Lieutenant Patten, published in your issue of the 11th inst., reminds me of an experiment I made many years ago, about 1880, with two alternate-current Wilde machines, at Latimer Clark, Muirhead and Co.'s Works. It will be remembered that these machines are magnetised with the current from two of the armature bobbins, which is connected into a continuous current. By passing the alternate current of the one machine into the armature of the other machine by the two ring collectors, and connecting the commutator brushes of the magnetising coils parallel to the collecting rings with a resistance in circuit, the machine ran as a motor. I took some measurements, but I cannot find the data now.

It is not easy to see how the synchronism of Lieutenant Patten's machine is maintained; a perfect balance between the winding of the machine and number of alternations is difficult to conceive.—Yours, &c., J. D. F. Andrews.

Glasgow, October 21, 1889.

ACCUMULATORS AT THE PARIS EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your last issue under the heading "Accumulators at the Paris Exhibition" you gave a list of awards which is incomplete and misleading. Will you allow me to correct it thus: Gold Medal to M. Faure and to l'Electrique de Bruxelles, working under the Faure and Julien patents. The Electrical Power Storage Company, of London, for its system of electrical distribution (King's patents) and the Société Française des Accumulateurs working also under the Faure and other patents, obtained Silver Medals. The Electrical Accumulator Company, of New York, did not exhibit individually, but derives benefit from the award to Faure.—Yours, &c., C. A. Faure.

19, Avenue de Villiers, Paris, October 19th, 1889.

THE SILVERTOWN STRIKE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As reports are still being circulated that we underpay our workpeople, we should be glad, with your permission, to re-state their average weekly wages and hours, viz.:—

Labourers	26s. 3d.	for 63	hours.
India-rubber departments	33s. 7d.	„ 63½	„
Cable and Telegraph departments	28s. 1d.	„ 60	„

for permanent work in healthy buildings.

We also employed about 350 women and girls, who, on an average, earned 13s. 5d. for a week of 54 hours.

These wages are higher than those paid by any other firm in our trade, and the directors have decided not to pay more.

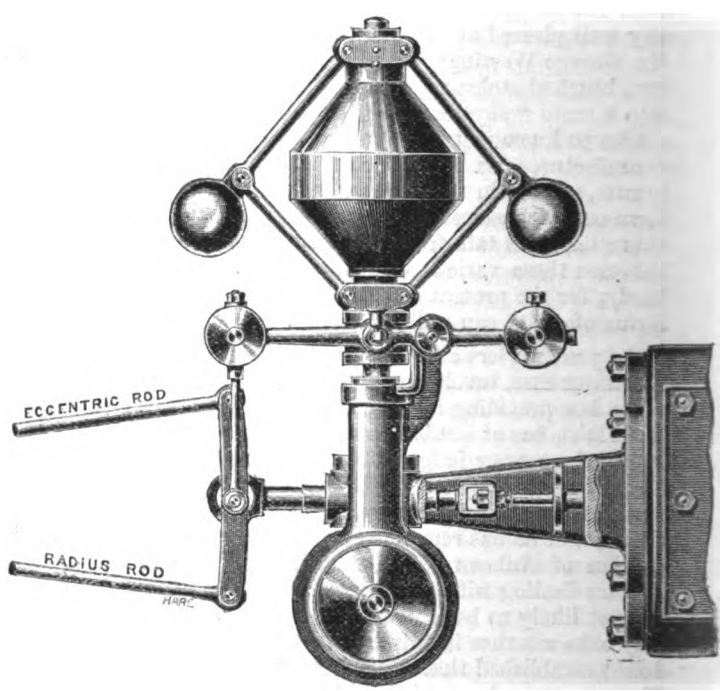
Hitherto the company have not engaged, or tried to engage, new hands, though a considerable number have applied for employment. The pickets who surround the factory are therefore employed in keeping out, not new men, but our former workpeople, who, so far as we are concerned, are free to return so soon as we can arrange work for them. To describe the stoppage of our works as a lock-out is therefore untruthful. It is the strike leaders who are responsible for the increasing distress in Silvertown and its neighbourhood.

The directors have been asked for an interview by a few of our workpeople, and by agitators who have never been in our employment and have made themselves conspicuous for misstatement and abusive language. Of course, the directors cannot consent to such an interview.—Yours, &c.,

October 17, 1889. Wm. J. Tyler, Secretary.

AUTOMATIC EXPANSION GEAR FOR ELECTRIC LIGHT ENGINES.

We illustrate below an improved form of automatic expansion gear made by Messrs. Ransomes, Sims and Jefferies, of Ipswich, and which is specially adapted for engines employed in connection with electric light machinery.



In this apparatus an independent gridiron expansion valve, working upon the back of the main slide valve, is operated through a knuckle joint by a link, one end of which is actuated by the cut-off eccentric, while the other end is held by a radius rod. The travel of the valve and the point at which it cuts off are governed by the position of the link in relation to the knuckle joint, and this position is varied in accordance with the load on the engine by a powerful and sensitive governor to which the link is connected. By this arrangement the cut-off can be varied between 0 and 70 per cent. of the stroke in proportion to the actual load for the time being on the engine, and the exact amount of steam necessary to do the work required being admitted at full boiler pressure up to the point of the cut-off, the entire benefit of the principle of expansion is obtained, and, in cases where an engine is required to work under varying loads, a very considerable saving in the fuel consumed is effected. In addition to the advantage arising from the economy effected in the fuel consumption by the adoption of this gear, the speed of the engine is maintained practically constant under very great differences of load, the variation in the number of revolutions in no case exceeding about 2 per cent.

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COMPANIES' MEETINGS & REPORTS.

The Eastern Extension, Australasia and China Telegraph Company (Limited).

The thirty-second ordinary general meeting of this Company was held on Wednesday, at Winchester House, 50, Old Broad-street, London, under the presidency of Sir John Pender, K.C.M.G.

The SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting, and the minutes of the thirty-first ordinary general meeting, which were confirmed by the present meeting and signed as correct by the Chairman.

The report of the Directors was taken as read.

The CHAIRMAN: Before I ask you to approve of the report, I shall as usual make a few remarks upon the working of our system during the last six months. The gross receipts for the half-year amounted to £256,757, against £239,926 for the corresponding period of 1888, showing an increase of £16,831, which is due to general growth of business all over the system. The working expenses have been £73,773, against £69,297 for the corresponding half-year, showing an increase of £4,476. This increase is principally caused by the opening of the Company's station at Roebuck Bay, in connection with the Western Australian cable, and the construction of a new pipe land-line between the cable house and office at Madras, about 1¼ miles long, costing £1,364, to replace the old one, which had been down for 10 years, and had become almost worn out. The net revenue has amounted to £138,736, against £125,804 for the corresponding period of 1888, showing an increase of £12,932. Interim dividends at the rate of 5 per cent. per annum have been paid for the half-year, leaving £26,236 to be carried forward, after debiting revenue with £50,000 on account of the Western Australian cable. It will be in your recollection that when we had our two cables interrupted to Australia through volcanic action, we decided, without any delay whatever, to put down an additional cable to Australia, so as to give us security and continuity in our connection with our Colonies. That cost a large sum of money, but it did not bring us in any additional traffic. It was practically a reserve, and since the cable was laid we have had good reason to congratulate ourselves on having laid it at the time we did, because there have been interruptions on the land lines of Australia, which would have very seriously interrupted the traffic if this cable had not been laid. Consequently, it maintains our revenue, and we have thought it would be a wise thing to pay for the cable as quickly as possible out of revenue. It has always been our policy, as you are well aware, to keep down capital as much as possible, and therefore we have taken a very broad view of this matter, and have written off at one sweep £50,000 on account of the cost of that cable. We are, however, still enabled to maintain our dividend as heretofore and to carry forward a very considerable sum to next half-year. As to the balance of the cost of the West Australian cable, we shall in dealing with it be determined to a large extent by the progress and prosperity of our system during the next six months. I think I mentioned when I addressed you six months ago that we were gradually carrying out our system of renewals in maintaining our cables. I see that in the last six months we renewed about 132 knots of cable, at a cost of something like £8,000. Since the 30th June we have renewed about a similar quantity, and with the further work we are now engaged upon we shall nearly complete the renewals that we have in view at the present moment. We are thus strengthening our system by these renewals, and are able to maintain a thoroughly efficient service. Taking the matter altogether, I hope you will approve the policy which I have just indicated, and which I think has worked on the whole very satisfactorily. We have also since this half-year began had an important interruption in our New Zealand cable—an interruption that extended over twelve days, and which so seriously interfered with the traffic between New Zealand and Australia that we determined without any delay to lay down a duplicate cable. We considered that, as the traffic with New Zealand was increasing, and the cable had been down for fourteen years, the sooner we duplicated it the better. We have, therefore, communicated with the New Zealand and New South Wales Governments, proposing duplication on certain terms, and not a minute too soon, because by the last advices we had from New Zealand we found that in that Colony the people were appealing to the Government for a duplicate line. Well, gentlemen, I am not sorry that they should have felt some inconvenience after their treatment of us a few years ago, when we were fighting with the New Zealand Government for our rights, which I think we practically gained. We have not yet received replies from the Governments interested, but I am hopeful that before a week passes over our heads we may be in a position to go on with the duplication of the New Zealand system. I think it is well that you should understand that duplication is a policy which we have found to work well. We have found it desirable to be ahead of our work, so to speak, and although this duplicated cable will not bring us any additional income, it will secure to us the income that we are already earning, and which I am glad to say is growing. I am pleased to tell you to-day that all our cables are in good working order. When I tell you that we have got something like 14,000 miles of cable at the bottom of the sea you will understand that it is a very great thing to be able to say that they are all working well at the present moment. I may also, in speaking of the New Zealand duplication, make a few other remarks in passing, because I think it is our business to give our shareholders as clear a view of our policy as possible. You have heard a great deal about a Pacific cable—an opposition line—the object of which is more to reduce our rates than to give increased facilities. Our present line is equal to a great deal more work than it at present transmits, but if the Governments of our Colonies or our own Government determine, for strategical purposes, that a Pacific line should be laid, we are quite prepared to undertake it. Not that it would bring any additional commercial traffic to us; but we feel that our system is so important, both commercially and politically, that it would be our duty to lay this line if we are fairly and properly remunerated. The line to New Zealand which we propose to duplicate would be what you may call the first link in the Pacific system, of which Fiji and the other islands lately acquired would form points of departure. Other work is very likely to be done in connection with our system. The French have New Caledonia, and I believe that must eventually have telegraphic communication. Therefore, while I may say that we have a consolidated position, we also occupy to some extent a restless position. We can never sit down quietly. We must meet every requirement as it comes up and maintain the position of invulnerability which I believe we now maintain. We have also negotiations with Spain going on at the present time for connecting the Philippine Islands. British North Borneo is growing and will require a telegraph by-and-bye; and altogether we have plenty of work before us, and it will be our duty to meet such requirements, always having due regard to the interests of our shareholders. At the last meeting I referred to our Six per Cent. Debentures, and remarked that 6 per cent. was a high rate of interest, and that I should be very glad to see them wiped out. But, unfortunately, those who hold the debentures know their value, and it is very difficult to get them out of the way. Though this is not the time to deal with them, we have the matter in view, and when they expire, which will be in 1891, we shall deal with them in a way that will, we hope, be perfectly satisfactory to our shareholders. We have a large number of debentures guaranteed by the Australian Government subsidies which are all being provided for, and by the time the subsidies expire those debentures will be extinguished. Therefore, I may congratulate you on the sound position which we occupy. I can also congratulate you on the friendly relations that exist between your Company, the Colonies, and in fact all those whom we serve, and I congratulate you again to-day on our being able to present to you a satisfactory dividend, and six months hence I hope we shall be in a position to add a handsome bonus to the dividend. I now move—

"*That the report and accounts of the Directors now submitted be received and adopted.*"

Mr. FRANCIS AUGUSTUS BEVAN seconded the motion.

The CHAIRMAN: If any gentleman wishes to put any questions to me I will endeavour to answer them to the best of my ability.

Mr. LEWIS said he saw that they had an account of investments of their reserve fund—nearly £700,000—yielding only 3 and 4 per cent., while, on the other hand, they had debentures to the extent of £320,000 on which they were paying 6 per cent. He thought if it were the case of any private man of business his first object would be to pay off that £320,000. Considering the price of money lately, he thought that the Six per Cent. Debenture holders had had a very fine time of it, but it was time that that rate of interest should cease. The Directors had taken £50,000, which was rather a large amount, out of the earnings towards paying off the debt on the Western Australian cable, leaving a balance for the half-year of £26,000 to be carried forward. Considering the dividend they were getting, he thought the Directors might have been content to spread the repayment of £50,000 over a little longer time; but, not content with that, they swept away again as much as the £26,000 they carried forward, making altogether a sum of £76,000 taken out of revenue. The revenue for many years had been constantly increasing, but the shareholders never seemed to get any more dividend. In 1880, and for five years afterwards, in each October they received 1s. 6d., and sometimes as much as 2s. added on, but since 1885 they had had the stereotyped 2s. 6d. It seemed to him that instead of the shareholders profiting it was their banker, who had £107,000 in hand, while the traffic and other debit balances amounted to another £80,000. That being so, the Directors could surely have employed another £12,000 in giving the shareholders an extra 1s. Besides the amounts mentioned they had bills receivable to the extent of £41,000. He really thought, therefore, that the Directors might have given another 1s. or 1s. 6d., and kept up the return which they had for so many years, but which always was knocked off. It seemed to him that people who were shareholders now, and who had been shareholders in the past, were building up a very fine business for those who were to come afterwards. He thought that a very heavy sum had been spent on the maintenance of the ships, seeing that they had not had very much steaming to do. He had not made these remarks in any spirit of opposition.

The CHAIRMAN: I confess that I like a little opposition, and the gentleman who has just addressed the meeting has spoken with a very fair amount of reason. We are a very prosperous Company, I admit, and, as I hinted to you, we have done a very big thing in wiping off that £50,000 on account of the Western Australian cable. But we are a Company in a position to be shot at, and we have so to protect ourselves in every way that, while maintaining a good and respectable dividend, we are adding very materially to the value of your property. The price of your shares shows it. You cannot have your cake and eat it too. If you get your shares increased in value by the policy we are pursuing, I think it may be said that we are doing much better for you than if we put the money into your pockets, when probably you would spend it. But you have not been strictly accurate in your remarks as to the bonus. We pay a bonus once a year. Last year we paid a bonus of 3s., and there is no reason, as far as I can see from the working of the concern, why next time you should not receive as good a bonus as last time. But we only pay it at the end of the year.

Mr. LEWIS remarked that they used to have the bonus in October as well.

The CHAIRMAN: Yes; but it was agreed after the Berlin Conference, when we had to reduce our tariffs to the extent of something like £40,000 a year, that we should pay the bonus once a year, and pay a steady 5 per cent. dividend and any additional amount that might be distributed in the form of bonus, which might, of course, fluctuate. This is only the interim half-year, and next six months, if we do not pay you a bonus, I think you will have good reason to speak hardly of myself and co-Directors.

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I may mention that we are approaching another Conference. These Conferences take place every five years. We were forced to come down very considerably in our tariffs at the last Conference, and I think at the present moment it is wise policy until we see what is going to be done at the next Conference to husband our resources. I admit that there would have been no difficulty in paying you 1 per cent. extra dividend. But I think it is very much better, and I believe I shall find that that is the view held in this room generally, to consolidate and add to the value of your property, complete your renewals, and do that which is necessary to maintain your sound 5, 6, or 7 per cent., as it may be. I think that is a better policy than having a dividend which keeps jumping up and down—a policy under which you get 5 per cent. at one time and 7 per cent. at another. We are strengthening our position, and we are securing you a permanent dividend. I may add one other remark, owing to what I heard the other day when I was coming from my place in the country. A gentleman said to me, "I always look almost to the day for your dividend. It always comes, and is always a respectable, good dividend. We trust to it for paying certain things." Now it is a very nice thing for investors to give you their confidence in that way, and I want to make the thing so certain that that sort of confidence will grow in the minds of investors. I do not wish to play into the hands of the Stock Exchange, but into the hands of sound and substantial investors—people who put their money into the Company to get a living by it. That is our policy; so far that policy has been pursued, and I believe you will admit that it is the soundest policy. As to the Six per Cent. Debentures, I think I gave you this hint—that they were too good for people to part with them; but if you will bring them all in to-morrow at a reasonable price we would at once take them.

Mr. LEWIS observed that it had been a very bad policy on the part of the Directors to specify no time at which the debentures were to be paid off.

The CHAIRMAN: But there is a time specified—1891.

Mr. LEWIS said he accepted the Chairman's statement, adding that he thought the debentures were hanging about the neck of the Company for ever.

The CHAIRMAN: You can have no better evidence of the progress of this Company than is afforded by these debentures. When we issued them we had a great deal of difficulty in obtaining the money. We have brought about confidence in the mind of the general public, and they are now pleased to have our debentures at 4 per cent. instead of 6 per cent. We have grown up step by step, and I think it is one of the most remarkable things done by these submarine telegraph companies that they have placed their debentures at about as low a level as is done in the case of any respectable undertaking in the city of London.

Mr. BLUNDELL presumed that the debentures would be paid off at par in two years, and that they would be absolutely extinguished then.

The CHAIRMAN: Do not ask me that. All I tell you is that these debentures will not be renewed at 6 per cent. He then put the motion in the usual way, and having declared it carried unanimously, said: That finishes the business of the day.

Mr. JOHN NEWTON proposed a vote of thanks to the Chairman and Directors for the manner in which they had conducted the business of the Company. In the early days of the Company some persons said that he (the speaker) was an adverse critic, but he did not think that he was. He agreed with Mr. Lewis making remarks, for it was advisable that there should be opposition before meetings when it was conducted in a friendly spirit. What had been said at that meeting had only confirmed him in the view he had maintained as to the debentures, but he was so satisfied at the way in which the business had been conducted that he would leave it in the hands of the Directors, especially in view of the abominable Telegraph Conferences, which always endeavoured to reduce the dividend paid by the Cable Companies. While there were Conferences, it was absolutely necessary that the shareholders should place implicit confidence in the Board, who had to deal with matters which could not be discussed at public meetings. As to the dividend which they were receiving, it ought to be remembered that 5 per cent. was as good as 7 per cent. eight or ten years ago. He was perfectly satisfied with what they received, and he had great pleasure in proposing that vote of thanks.

Mr. LEWIS, in seconding the motion, said he held Sir John Pender in such high esteem that he had recently taken some shares in a company because his name appeared as a member of the Board.

The motion was carried unanimously.

The CHAIRMAN: I am very much obliged to you, Mr. Newton, for the way in which you have proposed this vote of thanks to myself and the Directors. You have been watching these submarine cable companies from their very inception, and no man knows better than you their working and the care with which they have been conducted. A very great change has taken place in the value of money since these companies were established, and a very great change has also taken place in their financial status. What we could not do years ago we can do now. I hope we shall be able to maintain our position, and probably increase our dividend, and if we can maintain it while the bank value of money is going down, I think we shall enjoy the confidence of the investing public.

The proceedings then terminated.

The Monte Video Telephone Company (Limited).

The first annual general meeting of this Company was held on the 18th inst. at the offices, Abchurch-lane, under the presidency of Mr. Arthur Holland.

The SECRETARY (Mr. W. S. Hankey) read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, it will not be necessary for me to detain you in proposing the adoption of the report. As regards the profit of £10,439, we think it extremely satisfactory, because in the first place this was a new Company which had to contend against the usual dislocations which take place when an enterprise is transferred from one set of managers to another; and in the next place, we suffered in February last from a severe cyclone which occurred in Monte Video. Our wires were damaged very severely, casting considerable expense on our revenue account. Owing, however, to the able way in which our manager, Mr. Arthur Powers, dealt with the matter, the difficulties which he had to contend with were overcome, and he put everything to rights in due course. Comparing our expenses with those of other similar telephonic enterprises, particularly with that at Buenos Ayres, we find that our expenses are only 45 per cent. against 50 per cent., and we think that that is satisfactory considering the state of affairs when we first took over this enterprise.

A SHAREHOLDER: 45 per cent. of the gross receipts?

The CHAIRMAN: Yes, as against 50 per cent. in other cases. As we say in the report, we have written off a small amount for preliminary expenses and a small amount from furniture account, and in a few years those accounts will be wiped out. We have thus a balance of £10,302. 18s. 5d., which we propose should be devoted in the first place to a dividend of 6 per cent. on the Preferred Shares; and, secondly, to place £1,000 to renewal account. We consider that that is only a prudent measure, looking at the nature of this sort of undertaking. Then we propose the payment of a dividend of 2½ per cent. on the Ordinary capital. The £3,000, however, which remains after declaring the 6 per cent. on the Preference Shares is, as you will calculate, almost sufficient to pay 5 per cent. on the Ordinary Shares, but we have considered it prudent to limit the dividend on the Ordinary Shares to 2½ per cent. for the past year, to the 31st of July, and we shall carry forward a balance of £325. We shall ask you to pass a resolution declaring the dividends, and the warrants we propose should be sent out on the 21st inst. As the holders of the Preference Shares know, we have already paid them an interim dividend—in March last. The chief points we wish to call your attention to in this report are—first, the amalgamation with this Company of the Gower-Bell Company of Monte

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AND ALL ELECTRICAL PURPOSES.
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Video, a measure which we considered expedient to take, as it not only consolidates our position there, but also stops any other companies from having a footing in Monte Video. The number of subscribers we gained by that amalgamation has been somewhat disappointing, because when we took over the other concern we found that a great many of the subscribers were duplicates of our own, and they ceased the Gower-Bell subscription when we took them over. Then, we found that a considerable number of them were what we call bad payers, and it was rather unadvisable that we should keep them on. Another point we desire to call your attention to in this report is this—that in order still further to perfect our telephonic system, we have decided, under the direction of our able managers, Mr. Edward Powers and Mr. Arthur Powers, to institute what they call the multiple switch-board. It is believed that this improvement will make the system as perfect as possible, and it will do away with all the annoyance caused by the continual waiting for subscribers to be switched on. The cost of the multiple switch-board will be between £5,000 and £6,000; and we have also had to supply aerial cables, to keep the system in perfect order. This outlay has, of course, run away with a considerable amount, and we have made arrangements for increasing our expenditure on capital account by about £5,000. As regards the multiple switch-board, we find from the experience of others who have adopted it that the number of subscribers at once increased very fast, and if we may judge of the experience of the United River Plate Company of Buenos Ayres, we may expect that our subscribers will increase from 50 to 100 per cent. In the other company, the effect of the adoption of the switch-board was that the subscribers ran up from 2,200 to over 4,000 when they instituted the switch-board. That is what we have heard. The importance of such an increase in our subscribers on our Ordinary Shares will be manifest. We have a large surplus over and above the interest we have to pay on the Preference Shares, and any gain over and above that fixed interest, which we are quite capable of earning at present, will all go to enhance the dividend on the Ordinary Shares. As regards the future, in addition to the increase in the number of our subscribers which we fully expect from the institution of the multiple switch-board, we anticipate a great accession from the "boom" of prosperity which seems at last to have burst upon Monte Video and Uruguay. From reports that have come to hand in the past week, I see that in Monte Video there is not a single house to be let. That means that an extension of building must take place, and with the extension of building there will be an increased demand for the use of the telephone. A study of the trade reports of Uruguay, the centre of which is Monte Video, also shows that the trade of the country increased in 1888 over 1887 by over 30 per cent. I do not know that there is anything else that I have to bring to your notice, and I will therefore conclude by proposing—

"*That the report and statement of accounts now submitted be received and adopted.*"

Mr. THOMAS D. PETERS seconded the motion.

Mr. E. H. WOODS asked how it was proposed to issue the additional capital.

The CHAIRMAN: We have in hand a certain number of Preference Shares unissued, and we purpose issuing a certain number of them. He then put the resolution, which was carried unanimously. Subsequently, he proposed the declaration of the dividends mentioned on the Preference and Ordinary Shares.

The MANAGING DIRECTOR (Mr. Edward F. Powers) seconded the resolution, which was carried unanimously. He afterwards proposed the re-election of Mr. Holland, the retiring Director.

Mr. E. H. WOODS seconded the motion, which was carried unanimously.

The Auditors, Messrs. Gérard Van de Linde and Son, were next re-elected, and the proceedings terminated in the usual manner.

Brazilian Submarine Telegraph Company (Limited).

Report of the directors for the half-year ended 30th June last, to be submitted to the thirty-second ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, E.C., on Wednesday, the 6th November, at twelve o'clock:—

The revenue for the half-year amounted to £113,083. 6s. 10d., and the working expenses to £13,329. 11s. 9d. After providing £12,880 for debenture interest and sinking funds, and £1,593. 8s. 6d. for income-tax, there remains a balance of £85,280. 6. 7d.; to this is added £20,828. 17s. 2d. brought forward from 31st December last, making a total of £106,109. 3s. 9d. A quarterly interim dividend amounting to £32,500 has been paid, and £45,000 transferred to the reserve fund, increasing that fund to £259,660. 9s. 8d.

The Directors now recommend the declaration of a final dividend of 1s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 3s. per share, both free of income tax, which together will amount to £26,000, being a distribution in the aggregate of 7½ per cent. for the year ended 30th June, 1889, leaving a balance of £2,609. 3s. 9d. to be carried forward.

On the 31st July last the sum of £14,500 was transferred to pay off the 145 bonds of the 1884 issue, drawn for redemption in April last. This repayment reduces the debenture debt to £159,500.

The new cable to the Cape of Good Hope *vid* the West Coast of Africa was opened to the public on the 4th June last. Messages to and from South Africa now pass over this Company's lines between St. Vincent and Europe under the arrangement referred to in the last report. The receipts from this traffic justify the expectation of a satisfactory return on the capital invested by this Company in the shares of the African Direct Telegraph Company.

The various sections of the Company's line are in good working order.

The Right Hon. Viscount Monck and the Duke de Loulé retire by rotation at this meeting, and being eligible for re-election as directors, offer themselves accordingly.

The two auditors, Mr. Henry Dever and Mr. John Gane, also offer themselves for re-election.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended October 18, 1889, amounted to £4,477.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.—The directors of this company have declared an interim dividend for the half-year at the rate of 5 per cent. per annum, less income-tax, on the ordinary, and at the rate of 6 per cent. per annum, less income-tax, on the preference shares, the respective dividends to be payable on the 14th of November, the transfer books to be closed from the 25th to the 28th inst., both days inclusive.

EASTERN EXTENSION COMPANY.—This company notifies that the coupon on their Five per Cent. Debentures (1880 issue), due on 1st November proximo, will be paid on and after that date on presentation of the same at the Consolidated Bank, 52, Threadneedle-street, E.C. Coupons must be left three clear days for examination.

TAUNTON ELECTRIC LIGHTING COMPANY.—At a meeting of this company, on Monday, it was decided to increase the capital by creating 2,000 new shares of £5 each. This course had become necessary, it was stated, because of the increased demand for the electric light by consumers, to meet which new plant had to be laid down and larger premises erected.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended October 18, 1889, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,990.

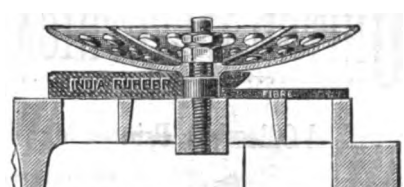
WEST INDIA AND PANAMA TELEGRAPH COMPANY.—At a meeting of the directors of this Company, held on Wednesday, it was decided to recommend to the shareholders at the approaching general meeting that, subject to final audit, a payment of 6s. per share, balance of arrears, and 6s. per share dividend to June 30th last on the First Preference Shares, and 10s. per share on account of arrears on Second Preference Shares be declared, placing £2,000 to reserve, and carrying forward £1,609. The receipts of this company for the half-month ended October 15th amounted to £2,053, as compared with £2,557 in the corresponding period last year, showing a decrease of £504.

CHANGE OF ADDRESS.—The offices of Mr. J. E. H. Gordon, engineer to the Metropolitan Electric Supply Company (Limited), and to the Electric Construction Corporation (Limited), have been removed from 4, Waterloo-place, S.W., to 11, Pall Mall, S.W.

WOODHOUSE AND RAWSON UNITED (LIMITED). — NOTICE OF REMOVAL.—Owing to the large increase in their business, this firm have found it necessary to take more commodious premises, and will next month remove to 30, Cannon-street, E.C.

NEW VALVE

No Rubber, Percha, or Leather.



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"12, John-street, Sunderland, 26th Sept., 1885.

"DEAR SIRS,—In reply to your letter of the 25th inst., the Valves I got from you have done their work well, and ARE AN UNQUALIFIED SUCCESS. I will continue to get them from you as required.—Yours faithfully, JAMES WESTOLL."

For further Testimony and Prices, apply to **MOSSES & MITCHELL, 68-71, Chiswell Street, London.**

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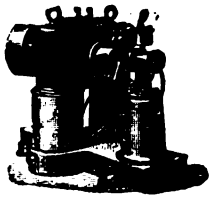
COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Oct. 23, 1889.	Rate per cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 23, 1889.	
							Highest.	Lowest.
£			**TELEGRAPHS.**		£ s. d.			
1,770,360	Stock	15/0	Anglo-American	51 52	4 16 2	Jan., Apr., July, Oct.	52¼	51½
2,614,820	Stock	30/0	Do. Preferred	87 88	5 9 11	,, ,,	88⅛	87⅝
2,614,820	Stock	...	Do. Deferred	17 17½	...	February	17¼	17
130,000	£10	5/0	Brazilian Submarine	13½ 13⅝	5 16 5	Mar., June, Oct., Dec.	13 13/16	13⅜
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	15	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3⅜ 4½	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	9¼	...
60,710	20	3/6	Direct United States	10½ 10½	5 18 11	Jan., Apr., July, Oct.	10 1/16	10¼
380,000	10	5/6	Eastern	13⅜ 14	4 12 0	,, ,,	13 7/16	13 1/16
70,000	10	6%	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	15½	15¼
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock	108 110	3 12 9	May and November.	110⅜	...
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	108½	...
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13 1/16	13½
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	103 106	4 14 4	January and July	...	...
179,177	10	4/0	Globe Telegraph and Trust	8⅞ 9	5 2 9	Jan., Apr., July, Oct.	9	8 1/16
178,992	10	3/0	Do. 6 per Cent. Preference	14¼ 15	4 0 0	,, ,,	14 15/16	14⅜
150,000	10	5/0	Great Northern	15¼ 15¾	4 15 3	Jan., July, and April	...	...
17,000	25	37/6	Indo-European	42 44	5 13 8	April and October	...	...
9,000	8	8/0	Reuter's	7 7½	5 6 5	April and October	7¼	...
15,609	10	5/0	West African Telegraph	9 10	...	...	...	...
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	...	...
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	10⅝	10½
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2½ 2⅝	...	...	2¼	2 1/16
34,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	...	...
4,669	10	*	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	...	...
45,181	15	9/0	Western Brazilian	9½ 10	7 10 11	May & November	10	9 1/16
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance	1 1/16 1 3/16	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	⅜ ½	3 6 4	...	...	...
55,000	5	3%	United River Plate	5 5½	2 14 7	January and July	...	...
			ELECTRIC LIGHT.					
23,003	5	1/2	Anglo-American Brush (£4 paid)	...	...	...	...	...
23,692	5	2/0	Do. (fully paid)	5 5½	...	February & August	...	...
79,934	5	...	Swan United (£3. 10s. paid)	5¼ 5⅜	...	...	5 1/16	5 1/16
500,000	10	...	Metropolitan Electric Supply (£3 paid)	3½ 4	...	...	3 1/16	3 1/16
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	44 46	5 4 9	March and July	45¼	44¼
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19½	5 2 7	February & August	19½	19

* No dividend since May, 1880.



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THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

No. 598.—Vol. XXIII. FRIDAY, NOVEMBER 1, 1889. Price Fourpence.

NOTES.

We would remind our readers that on Monday next, November 4th, the Institution of Electrical Engineers holds its first dinner, and it is hardly to be doubted that this innovation will be successful and will be continued. The Institution of Electrical Engineers is in this matter only taking one more step in imitation of the older and worthy Society on the lines of which it is modelled, and in doing so it is taking a step in the right direction to draw its members into closer social relations, and render possible more united action. We understand that a number of distinguished guests will be present, and amongst those who we believe have already accepted are the Marquis of Salisbury, the Astronomer Royal, the Hydrographer of the Admiralty, Mr. Courtenay Boyle, Major Marindin, R.E., Dr. Anderson, the Presidents of the Royal Society, the Physical Society, the Institution of Civil Engineers, and of the Iron and Steel Institute.

Whatever may be the outcome of the resolution relating to the forthcoming Exhibition at Edinburgh which was brought forward by Major Flood-Page at the last meeting of the Electrical Trades Section, there can be but little doubt that the time has arrived when some such action should be taken. The day has gone by when the electrical industry existed on sufferance, and when electricians were content to pay heavily for the honour of exhibiting their wares; and if this movement is supported with anything like unanimity, the result can hardly fail to be satisfactory. At the same time, we would remind those who assert that because these Exhibitions bring in no direct increase of business they are therefore useless institutions, that although the direct increase may be infinitesimal, the holding of Exhibitions all over the United Kingdom in which electricity plays so important a part may be indirectly beneficial to the trade. The public is by this means more and more familiarised with the beauty of the electric light and the advantages of electric power—a process which in the long run can only end in increased business. We trust, therefore, that the spirit of compromise will prevail, and that the promoters of the Edinburgh Exhibition of 1890 will see their way to concede any reasonable demand on the part of the electrical industry.

We are glad to see that *The Times* publishes last Saturday a letter, which will be found in another column, from Sir Henry Roscoe stating that the matter of a memorial to Dr. Joule has been taken in hand by the Royal Society, and that a committee has been appointed to deal with the question. The Council of the Royal Society is the chief official representative of British science, and in taking the initiative into their own hands we feel sure that the Council will find themselves supported and strengthened by all those who are in any way anxious that the memory of a great name should be fitly preserved, and honour done to one who has conferred lasting honour on his country and his age.

One memorial which we already possess of Dr. Joule's life-devotion to the pursuit of experimental inquiry is the most valuable volume of his collected papers, published by the Physical Society of London. A glance at the Table of Contents shows the immense range over which Dr. Joule's inquiries extended. His first Paper was communicated in 1838 to Sturgeon's "Annals of Electricity," and describes an electro-magnetic engine, having the field-magnets arranged in a manner not unlike that of a Ferranti alternator, and having an ingenious commutator. Starting from this Paper, there is hardly any portion of the sciences of electricity and heat on which he has not left the impress of his fertile invention and intensely accurate quantitative research.

In one of Dr. Joule's Papers occurs an account of an electric balance in which the stress effect existing between conductors traversed by electric currents is employed to weigh or measure the currents. This fact has, as we all know, been taken advantage of by Sir W. Thomson in the construction of his beautiful ampere-balances.

We publish in another column an abstract of a Paper by Dr. Henry Morton, on the "Energy-Relations of Gas and Electric Lighting." Dr. Morton takes as his means of comparison a 16-candle Sugg-burner consuming 4 cubic feet of gas per hour, and an incandescent lamp of 16 candles yielding 160 candles per horse-power. On the assumption of a 5 per cent. utilisation of the potential energy of the coal by a dynamo and steam-engine, and a waste of 50 per cent. of the same energy in the production of radiant energy by combustion, the author arrives at the conclusion that in producing light from coal, as far as energy waste is concerned, the process of steam-engine, dynamo, and incandescent lamp is about on a par with the

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process of gas making and gas combustion. We think, however, that exception may be taken to these figures on the ground that an injustice has been done to the incandescent lamp. Good modern incandescent lamps can be worked at a temperature equal to 200 candles light per horse-power, and yet have a fairly long life, and in proportion as the price of the lamps is reduced, it will be possible to run them economically at still higher temperatures. The balance is, then, considerably in favour of the incandescent lamp.

It must not be forgotten that the temperature of the gas flame is not capable of being raised in the same manner in which the filament of a carbon incandescent lamp can be. The value of the incandescent lamp as an energy-translating device increases with the temperature. A valuable Paper on this subject was communicated by Prof. E. L. Nichols, of the Cornell University, to the *Transactions* of the American Institution of Electrical Engineers, in which the luminous efficiency of arc and incandescent lamps is considered, and brought into comparison with gas and other means of illumination, with the result of showing the superior efficiency of the electric incandescence method over those depending on combustion.

The results of experiments with lead-covered and iron-armoured cables which M. Jacquin brought before the Paris Electrical Congress, and which we give in detail in another column, are of importance because showing that, from a practical point of view, there is no appreciable waste of energy from eddy currents and hysteresis when such cables are used for alternating currents. With a lead-covered cable the loss was only 1 or 2 per cent. of the ohmic loss, and with a cable having the usual iron armour it rose to 18 per cent. Under very unfavourable circumstances, when both the lead and iron covering of the out and home cable were connected, the loss was 35 per cent.; but as such a connection can be always avoided, the loss of 18 per cent. of the ohmic loss need alone be expected in practice. This is so small an amount that it may well be neglected entirely.

Our esteemed contemporary, the *Electrical World* of New York, publishes in its issue of October 19th a carefully-compiled list of the electric railways at present in operation or in progress in the United States. The table shows a grand total of 179 roads, 1,260 miles of track, and 11,884 cars, some 113 roads being actually at work. Considering that at the end of 1885 there was only one solitary electric railway in operation, the growth of electric traction has been something phenomenal even for such a go-ahead country as America; and we can only hope that the quality of work done has been equal to its quantity. Not content apparently with this brilliant record, our enterprising cousins are turning their attention to this country. If they succeed in infusing the English tramway companies with some of their own innovating energy, there will not, we venture to say, be a very close scrutiny as to who brought about the desired result.

A fatal street accident caused by an electrical lighting current in New York has revived the crusade against overhead wires, and the business of chopping down poles by order of the Mayor is proceeding vigorously. This does not, however, prevent the erection of new ones—both operations going on simultaneously, and apparently under sanction of some contradictory legal rulings. Nevertheless, in the present temper of the New York public, rendered very excited by the painful incident reported in our American correspondent's letter this week, it is almost certain that a large number of wires will be added to the underground conduits, and that these receptacles will be increased and extended. The result will be watched with great interest in this country, not less than in the States, especially through the winter months, when the wires will be put to their severest strain, and the efficiency of the conduits tested to the utmost.

We have heard so much about the danger which in New York and other American towns arises from infiltration of gas into electric light conduits, that the fact of a similar phenomenon having been observed here is well calculated to cause alarm. Apparently the Strand District Board only concerned itself with the question of inconvenience arising from the escape of gas by means of an electric light conduit into a house in Norfolk-street; but the matter has a far more serious aspect, for an explosion might at any time occur. If we remember rightly, infiltration of gas into the large conduit carrying the electric light mains over the Kensington Court estate at one time caused some difficulty, and special precautions had to be taken to keep the conduit thoroughly ventilated. It is important to note that the danger increases with the size of the conduit. The quantity of gas which can accumulate in a small iron pipe partly filled with conductors may, perhaps, be insufficient to explode with destructive effect, to say nothing of the greater ease with which a small pipe can be kept tight; but when it comes to the employment of large brick culverts, both the difficulty of preventing infiltration and the destructive effect of an explosion are greatly enhanced. Now brick culverts are used in order to avoid the necessity of insulating the conductor, which in this case is composed of bare copper strip. The absence of insulation, again, renders the occurrence of a spark, which might fire the explosive mixture, far more likely than when the mains are properly protected, so that this system of mains, which now seems a favourite one with several companies, would hardly appear so safe as in the interest of electric lighting is desirable. It would, at any rate, be wise to defer its wholesale adoption until prolonged experience has proved that the danger to which we have alluded can be effectively guarded against.

In the letter on electric traction which will be found in our correspondence columns, Mr. W. D. Sandwell takes up the cudgels in defence of his "system" of electric tramcar. His arguments amount briefly to this: The cells require over 38 square feet of floor space, and only 33 square feet are available under the seats; cells which can be accommodated in the smaller space have not enough storage capacity; a spare

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armature is a very handy thing, and to employ two motors on the same car is an absurdity, because the cells cannot supply current to both at the same time. Taking the last point first, our correspondent seems to be under the impression that where two motors are employed the object is to work them in parallel when starting and when a spurt is required. This is not so. The two motors are coupled in series on starting and on heavy gradients, and in parallel when running on the level at full speed. If used in this way, the effect of the arrangement is exactly the opposite of that ascribed to it by our correspondent. The strain on the battery is relieved, and not augmented, at starting. His contention that a spare armature is a necessity is contradicted by the practical experience gained in America with electric tramcars and by English experience with dynamos. There are many ship-lighting dynamos which are kept running for weeks together without a moment's stop, and yet their armatures do not break down. As regards the want of storage capacity, this has never been a trouble: the real difficulty is the limited rate of discharge, and this can only be overcome by an improved construction of cells—not by the way they are placed. Taking our correspondent's figures, we find that he can with his tender employ 15 per cent. more battery-power, as compared with the usual arrangement of putting the cells under the seats. This 15 per cent. is, however, not a clear gain, for we have to move the additional weight of the tender; and after making allowance for the extra resistance of four more wheels, especially on curves where the tender will be dragged to one side, the margin left is so small that a very trifling improvement in the batteries themselves will bring the balance even, to say nothing of the almost fatal objection to the greater length of his arrangement.

It was with justifiable pride that Mr. Massingham, in addressing a meeting of the shareholders of the Taunton Electric Lighting Company last week, referred to the continued prosperity of the Company. The Taunton station is, of course, a very small affair when compared to many on the Continent and in America, but its record is one which it would be difficult to surpass. How greatly the success at Taunton has contributed to the advancement of electric lighting in this country may, we think, be fairly gauged by the fact that in almost every instance where an Electric Lighting Committee has reported in favour of a Municipal station, they have justified their recommendation by what they had seen or by what had been done at Taunton.

The Conference of electrical workmen, commented upon in these columns a fortnight ago, is developing into an "Operative Electricians' Union," which is to embrace all telegraphic, telephonic, and electric-lighting workpeople in the kingdom. A meeting pledging itself to support this Trades Union was held in the Albion Hall, London Wall, last Saturday night; and although the real origin of the movement was, like its real object, left in vague uncertainty, the crowded audience lost no time in being enrolled as members. Of course the inevitable Member of Parliament was present, and of course he told them that they ought all to join the Union, although "he did not know whether they had any grievances to complain of." This over-candid friend—Mr. J. Rowlands, M.P.—also counselled them to have nothing to do with "outsiders," a piece of advice which, after listening to him, the meeting perhaps wished they had followed a little earlier. We, also, are not aware that there are any legitimate grievances which electrical operatives could not redress by less costly means than the support of a Trades Union, and we suspect that "outsiders" like Mr. Rowlands encourage such organisations quite as much for political as for industrial purposes. But that is the workman's affair, and as he seems to know no better, while nobody has the courage to enlighten him, we can only leave him to his own devices.

We regret to hear that the publication of the *Fortschritte der Elektrotechnik* is likely to be discontinued, as it has not met with sufficient support to make it a financial success. We would suggest, however, that if the *Fortschritte* were published annually in lieu of quarterly, not only would the labour, and consequently the cost of preparation, be considerably lessened, but the volumes would be handier and less expensive—without, we think, being appreciably diminished in value.

A Spanish Cable.—The Spanish Government have obtained a concession for laying a cable between Algesiras, Tangier, Ceuta, and Melilla.

Belgian Exhibition in London.—It has been decided that the fourth in the series of National Exhibitions at Earl's-court shall be a Belgian one.

Lighting of Cadiz.—We understand that the specification and conditions of tender for the lighting of the city of Cadiz by electricity are now published.

Portrait of the late Mr. La Trobe-Bateman.—We learn that Messrs. Morris and Co., of 392, Strand, are about to publish, by permission, a portrait of the late Mr. La Trobe-Bateman.

Birkenhead—The minutes of the Finance Committee of the Town Council, recommending that a Provisional Order should be applied for, were confirmed at the last meeting of the Council.

Electro-Harmonic Society.—A smoking concert will take place this (Friday) evening, at St. James's Hall Restaurant, Regent-street, W., at eight o'clock. An excellent programme is provided.

The Electric Lighting of the Yldiz Palace.—MM. Sautter, Lemonnier et Cie. have undertaken the lighting of the Yldiz Palace at Constantinople on the occasion of the visit of the Emperor of Germany.

Electricity in Brazil.—Rio advices report the formation of an electrical company at São Paulo, under the title of the "Companhia Electrica de S. Paulo." The capital is 80,000 milreis, in 1,600 shares of 50 milreis each.

The Telegraph Construction and Maintenance Company.—It is announced that Sir George Elliot, M.P., has been elected Chairman of the Telegraph Construction and Maintenance Company (Limited), in place of the late Sir Daniel Gooch.

Exeter.—The Town Council have instructed the city surveyor and superintendent of the fire brigade to report on the position of the electric light wires and posts in the streets of the city, especially in relation to the extinction of fires.

Leeds.—The Electric Lighting Committee of the Corporation, at a recent meeting, decided to proceed at once with the lighting by incandescent lamps of the rate office in the municipal buildings, and also of the offices of the police department of the Town Hall.

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Cork.—A Special Committee of the Corporation, having acquired information, is unanimously of opinion that it would not be in the interest of the ratepayers that the Corporation should themselves apply for a License or Provisional Order to supply electricity.

Paris Exhibition Awards.—The *Journal Officiel* of Oct. 20 contains a list of the awards granted to the principal *collaborateurs* of the firms who contributed to the success of the Exhibition. Silver medals were awarded to Mr. F. V. Andersen (Latimer Clark, Muirhead and Co.) and to Mr. Spratt (Elliott Bros.).

Bournemouth.—A deputation from the Brush Electrical Engineering Company waited on the Lighting Committee of the Bournemouth Commissioners a few days since, with a view of explaining this company's proposals with regard to Bournemouth, where the Brush Company have a 2,000-light plant already at work.

Newcastle.—The two electric lighting companies have been unable to commence operations on account of a technical point of law, which awaits the decision of the law officers of the Crown. Until this point is settled, the Board of Trade cannot grant the licenses, and, of course, meantime the companies are absolutely powerless.

Concert at the Edison-Swan Works.—The first of a series of concerts to be held this winter was given at the Edison-Swan Company's Works, Ponder's End, on Wednesday evening, 23rd inst. A good programme was provided, concluding with an interesting comedietta. Mr. Edward Gimingham acts as secretary to the concert committee.

Plymouth.—A meeting was held at the Athenæum, Plymouth, on Monday afternoon last, to discuss the desirability of giving to the three towns of Plymouth, Stonehouse, and Devonport the advantage of an electric supply. The meeting was addressed by Mr. Bingham and Mr. Lowrie, of the House-to-House Electric Supply Company.

Brazilian Purchases of Telegraphic Apparatus.—Rio advices of October 7th state that as a beginning towards the proposed addition to the capacity of the State telegraph lines, the Director-General of that service has ordered from Europe some 16,000 kilometres of wire, 14,000 insulators, and 240 instrumenst—the whole to cost about 350,000 milreis.

The Leeds Electric Lighting Report.—It is a somewhat curious fact that the Nottingham Corporation, having at their own expense and with sanction obtained copies of the Leeds Electric Lighting report, decided, after carefully considering the arguments used therein, to apply for a Provisional Order, the Leeds Corporation, on this same report, refusing to apply.

The Blenheim Telephones.—We have received from Messrs. Blenheim and Co., of Egham, Surrey, a copy of their latest catalogue, in which is given an illustrated list of their telephones, bells, fire alarms, indicators, &c. The catalogue contains a long list of users of the telephones made by this firm, and from the testimonials given the instruments appear to give general satisfaction.

The Electric Light in Railway Trains.—A special train, lit by electricity, was run on Saturday by the Cheshire lines Committee, from Liverpool to Manchester and back. The system employed was that of Mr. Radcliffe, telegraph engineer to the Great Northern Railway. The light gave general satisfaction, and its immediate introduction into the regular express service was decided upon.

Eastbourne.—At the last meeting of the Town Council the General Purposes Committee reported that a letter had been received from the Eastbourne Electric Light Company, enclosing for submission to the Corporation a draft of the Provisional Order which the company proposes to apply for. The Committee recommended that a special meeting of the Council should be held on December 2nd, to consider the question.

Hackney District Board of Works.—At the last meeting of the Board, the General Purposes Committee reported that they had had under consideration, notices from the following electric lighting companies of their intention to apply for Provisional Orders:—Sydney Moorse, the House-to-House Electric Light Supply Company, the London Electric Supply Corporation, the Electric Construction and Maintenance Company, and the Metropolitan Electric Supply Company.

An Electric Motor Installation.—A factory covering a considerable extent of ground, and five stories in height, is being built at Leeds for the firm of J. and W. Campbell and Co., of Glasgow. In this building there will be about 800 sewing-machines, as well as the necessary number of cutting-machines to keep these going; all of them will be operated by electric motors. The contract for the electrical equipment has been given to Messrs. McCulloch, Sons, and Kennedy, of Kilmarnock.

Birmingham.—According to the *Birmingham Post* of yesterday, Messrs. Holmes and Vaudrey, of Liverpool, have arranged with Messrs. Chamberlain and Hookham to purchase their interest in the Provisional Order recently obtained by them for a comparatively small sum, with a view of transferring the Order to a company which is about to be formed. An influential directorate is in course of formation, and the capital of the company will be in excess of the minimum fixed by the Order.

Electricity in the Nizam's Dominions.—The Chudderghaut Municipality have received a proposal from the representative of Messrs. Siemens Brothers, of London, to light the whole of the streets within the municipal limits for a yearly payment of 11,000 rupees. The firm offers to put up 13 lamps for every 20 at present in use lit with kerosine. If the terms are accepted the municipality would effect a saving of between 3,000 and 4,000 rupees a year, besides having the streets much better lighted.

An Improvement in Primary Batteries.—We understand that a Mr. Harris has recently made an improvement in the nitrate of soda battery. Contact screws are avoided by connecting elements in series at the base of the cells, and corrosion of the contacts is thus obviated. The result of Mr. Harris's labours has been the production of a portable lamp suitable for use in mines, &c. The advantages claimed for the new battery and lamp are numerous, but we hope before long to put our readers in possession of more detailed information.

The Telephone in East Kent.—The whole of East Kent is being gradually brought into telephonic communication by the operations of the South of England Telephone Company. Dover, Folkestone, Canterbury, Faversham, Margate, Ramsgate, and Sandwich have had exchanges for some time, and now the company have extended their line to Hythe and Sandgate. Exchanges were opened in these two places last week, and subscribers can speak to Dover and the other towns mentioned. It is intended ultimately to place East Kent in communication with the metropolis by means of a trunk line.

Electricity in Works and Mills.—In the course of a Paper on "The Application of Electricity to Works and Mills," recently read by Mr. T. Vaughan Hughes to the South Staffordshire Institute of Iron and Steel Works' Managers, at Dudley, the reader said that there was everything to recommend an electrical transmission plant. Waste heat from blast furnaces could be used miles away, steam boilers could be placed near the colliery to save haulage of coal, the power of a stream or river could be used, and hundreds of horse-power could be conveyed along small copper wires, whilst the places could be lighted up by electricity. All this could be done well and cheaply.

Monte Video.—The central station of the Compañia Nacional de Luz Electrica, at the Arroyo Seco, Monte Video, was recently inaugurated with considerable ceremony. The building is 77 metres by 51. The 300 horse-power boilers, five in number, are on the Belleville system; the machinery is all from Ganz and Co., of Buda-Pest, and comprises eight 150 horse-power engines and eight Zipernowsky alternators of 150 horse-power each, driven direct. The primary pressure is 1,800 volts, the secondary 100 volts. The present capacity of the station is equal to 15,000 16 candle-power lamps. The lighting of the new city has already made great progress, and every week new districts will be added till the service is completed through both the new and the old city, in all about 5,000 lamps will be required.

The Electric Light in the Royal Navy.—During the recent naval manœuvres it was found that the search lights on ships

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of the M class were awkwardly placed. The Admiralty has, therefore, decided to adopt the suggestion of Captain Wilson, of the "Vernon," with the view of remedying the defect. In place of the towers, which are very inconvenient, owing to the seas breaking against them, a portable platform will be shifted inboard, so that the electric light may only be used when actually required. This arrangement will give the ships extra stability, and the search lights will not be too much in evidence during an action. The new plan is shortly to be tried on the "Marathon" and "Magicienne."

Bradford.—At a special meeting of the Town Council on Saturday an additional sum, amounting to £25,000, was granted to the Gas and Electric Lighting Committee in order to enable them to complete the works begun, and also to enable them to meet the extra and unexpected demand for the supply of the electric light. The chairman of the committee (Alderman F. Priestman) stated that the committee had no intention of spending the additional sum of £25,000 at once, but it was necessary to have a smaller sum of, say, not less than £10,000 wherewith to carry on the branch already established. Their present borrowing powers were £20,000, and that sum had been slightly exceeded. He gave the Council a pledge that nothing more should be expended beyond what was required to carry on the present installation without a special resolution of the Council.

Cambridge.—At the last meeting of the Cambridge Improvement Commissioners the electric lighting report of the Joint Parliamentary, Paving, Drainage, and Lighting Committees came up for consideration. The report, which was of great length, concluded by recommending that the Commissioners should themselves apply for a Provisional Order, and that the alternate-current transformer system should be employed. The report was adopted unanimously. Mr. Ferranti sent in an estimate for a 9,000-light station, building, plant, and mains complete for £25,000, at the same time advising the Committee to start with a 6,000-light station, costing £19,000. From the latter, he estimated, on the basis of all the lamps being taken up and burning on the average three hours per day, that an annual income of £7,666 would be derived, yielding a profit of over £2,000.

Great Yarmouth.—Mr. Cockrill, the borough surveyor, has submitted a report to the Town Council relating to the electric lighting of the borough. Since making his last report Mr. Cockrill says that he has received an offer from a firm of electricians to put in an installation and supply electricity at 3¾d. per Board of Trade unit, equal to gas at 3s. 3d., this price to include all interest, capital charges, and allowances for depreciation. The report then proceeds as follows:—"I would urge upon the Council that it is advisable that they should seek to obtain powers themselves, and that such powers should extend to the whole of the borough. My opinion is that a small installation could be commenced, providing for lighting the busiest portion of the town. If properly designed such an installation as I have sketched out could gradually be extended and would pay its way."

Stafford.—A special meeting of the Town Council was held on Tuesday last to receive the report of the Special Committee on the question of electric lighting. Alderman Peach (chairman of the committee) moved that consent be not given to the Provisional Order of the Midland House-to-House Electricity Company, and that application be made for the granting of a Provisional Order authorising the Corporation to erect electric works. They had a capital at stake at the gasworks of about £85,000. Under these circumstances it would be suicidal to allow any company to come and share the profits derived from lighting. If their business at the gasworks increased in the same ratio they would be compelled in the near future to spend something like £15,000 to increase their accommodation, and it seemed to him more desirable to spend the money in providing an electric installation. The resolution was carried, and an Electric Lighting Committee was appointed to take the necessary steps to give it effect.

The "Local Authority" under the 1882 Act.—The Electric Lighting Act of 1882 gives the "local authority" power to give or refuse assent to the application of a company for a Provisional Order, and also to make an application on its own account. The schedule as to the Act mentions three "local authorities": (1) the Town Council; (2) the Police Commissioners; (3) "places within the jurisdiction or limits of any public commissioners or board (other than any of the bodies hereinbefore mentioned) charged by any local Act with the duty of lighting the district within their jurisdiction or limits with gas." The question has arisen in connection with the electric lighting notices in Edinburgh, who, in the case where there is a legally-appointed Gas Commission, is the local authority"? The Lord Advocate for Scotland has recently given an opinion to the effect that the Town Council, as Police Commissioners, is the "local authority" for Edinburgh, implying that the Edinburgh and Leith Gas Commissioners have nothing to do with it.

St. Elmo's Fire on Ben Nevis.—In a Paper on "St. Elmo's Fire on Ben Nevis," by Angus Rankin, in the *Journal* of the Scottish Meteorological Society, it is stated that St. Elmo's Fire as seen occasionally at the Ben Nevis Observatory takes the form of jets of light on the tops of all objects that stand any height above the general level of the roof of the Observatory. In a very fine display the tops of the objects are quite ablaze with the light, which then glows and hisses in brilliant tongues of white and blue from four to six inches in length. Nor is the phenomenon confined to these objects alone in the finer displays, but if the observer stands on the roof, his hair, hat, pencil, &c., glow with it as well, and when he raises a stick above his head the stick has also a long flame at the top. Further, however, than having a slight tingling in his head and hands he suffers no inconvenience. The hissing is a very marked characteristic of the phenomenon, being always heard during ordinary displays, though in the feebler displays, when the light can barely be seen, it cannot be distinguished from the hissing of the wind and the snow drift.

A Private Central Station.—The residences of Mr. Peter Denny, the senior partner, and of six other partners, in the well-known Dumbarton shipbuilding and engineering firm of Denny and Co., are about to be fitted throughout with the electric light. Helenslee, Mr. Denny's mansion, and the other six houses, are all of considerable dimensions, and are situate in the same neighbourhood. The generating plant for supplying the necessary current will be located in a central station, and will consist of a Willan's triple expansion engine coupled direct to a Siemens' shunt-wound dynamo. This dynamo will charge three sets of E.P.S. storage batteries of 54 cells each. The batteries alone will be capable of supplying current for 300 20-candle lights, and if the engine is kept running at the same time a total of 600 such lights can be supplied. As in house lighting rarely more than half the total number of lights are used at one time, this station will, in all probability, be large enough to supply the whole neighbourhood, which consists of between twenty and thirty large houses. The contract for the lighting of the residences has been placed with Messrs. Muir, Mavor and Coulson.

The Taxation of Machinery.—A meeting of manufacturers in the Stroud district was held at the Imperial Hotel, Stroud, on Friday, to hear an address by Mr. Humphreys Davies, of London, the secretary of the National Society for the Exemption of Machinery from Rating, and to discuss the formation of a local branch. The chairman pointed out the importance of the crisis at which the question had arrived, and Mr. Humphreys Davies proceeded to explain the objects of the society and the steps which were being taken to perfect its organisation throughout the country. He stated that the promises of both parliamentary and pecuniary support were most encouraging, and that there was every reason to believe that before the final decision of the House of Lords could be given on the Chard appeal, the Bill promoted by the Associated Chambers of Commerce for the exemption of machinery would be passed. It was also stated that it was intended to raise a guarantee fund of at least £50,000, and that the success of the attempt was practically assured owing to the energetic manner in which the Chambers of Commerce branch associations in all the manufacturing centres had taken the question up. A number

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of similar meetings are being held throughout the country. The central offices of the society are at 22, Buckingham-street, London, W.C.

Gas in Electric Light Mains.—At the last meeting of the Strand District Board attention was called by Mr. Cole to the state of Norfolk-street. It was not very long ago that this roadway had been repaired, and now it was taken up again. Why was this done? The Surveyor said the position of things was this: the gas company had carried out their works before the electric lighting company had commenced laying their mains. The electric lighting company laid a hollow pipe through the middle of the street, and the joints not being well made, the gas from the gas company's pipes made its way into the electric main, and then found its way into one of the houses, No. 4, Norfolk-street. He had written to the gas company telling them that the Board would require them to watch the work for a period of six days after the pipes were laid. Mr. Cole thought the gas company should be compelled to do the utmost that the surveyor required. Mr. Fowler said it was a matter worthy of full consideration. He knew that the gas escaped continually from the gas mains, and the Board or some authority should adopt some means to prevent this general escape of gas. He could not see why the pipes of the electric lighting companies should not have their joints properly made. Ultimately the subject was referred to the Works Committee.

Magnetic Leakage in Dynamos.—The following is an abstract of a Paper on Magnetic Leakage in Dynamos, read by Prof. H. S. Carhart, of Michigan University:—Two dynamos of the Mather and Edison type respectively were tested; the former was a small machine of 500 watts capacity, built by a student in the laboratory, the latter an Edison of 5,000 watts capacity. In the small machine the leakage was due to some projecting machine steel studs which carried the armature yokes. The number of magnetic lines cut by the armature when the machine was coupled as a self-exciting shunt dynamo was determined, and then the steel studs were replaced by brass and the determinations were repeated. The result was 190,000 and 252,000 lines of force respectively, or a gain due to removing the steel studs of 32·6 per cent. This was partly due, however, to increase in the field when the leakage was stopped. Hence the machine was independently excited by a storage battery, and the number of lines determined in the two cases as before. The result was 164,600 and 184,100 lines cut by the armature with and without steel studs, a gain of 11·2 per cent. The leakage in the Edison machine was due to the iron bed plate. A plank base was made, and the number of magnetic lines cut by the armature was determined, first with the iron base and then with the plank, the machine being self-exciting and running at the same speed in the two cases. The number of lines was 1,510,000 and 1,605,000, a gain of 6·25 per cent. due to removal of the cause of leakage.

Military Telegraphy.—A Paper was recently read before the Aldershot Military Society, upon "The Field Telegraph and its Relation to Military Operations," by Col. Jelf, who lately commanded the Telegraph Battalion of the Royal Engineers. Col. Jelf stated that the two divisions forming the Telegraph Battalion, assisted by their reserve, are calculated to be able to provide for a head-quarters and eight sections—that is, for 800 miles of communication, the allowance for two army corps—while two sections, with 200 miles of telegraph, would be ready to start in 48 hours after receipt of the order to mobilise. Each section carries only 20 miles, but its reserve of 80 miles, with all poles, apparatus, stationery, &c., is kept ready packed at Woolwich, and ready to be put on board transports at the shortest notice. Having gone thoroughly into the subject, and dealt with the tactical advantages and disadvantages of telegraphy in war, Col. Jelf concluded by stating that, having had opportunities of inspecting the field telegraph equipments of the great military Powers and comparing them with our own, he was perfectly satisfied that in telegraphy the British Army was more than holding its own, and he had every confidence that the Telegraph Battalion would prove worthy of the traditions of its short but not inglorious past. Subsequently, Capt. Glen, of the Inns of Court Rifles, submitted a scheme for a light field telegraph to be used instead of visual signalling, which may frequently be read by an enemy from a distance, besides being slow in operation, greatly dependent upon weather, and laborious.

French Tramway Statistics.—Up to the end of 1888 the total length of tramways for which concessions had been granted stood at 789 kilometres, including those lines worked by animal and mechanical power. In the first class of tramways, namely, those worked by animal power, 590 kilometres are included, leaving only 199 kilometres as worked by mechanical means. Out of the 789 kilometres conceded, 743 kilometres were being operated at the end of the year. Tramway communication has reached the highest point of development in the Department of the Seine, where there are laid 252 kilometres on which animal power solely is used, it being stated that the trials made with mechanical traction have been unsuccessful, and consequently abandoned; this, however, not applying to electrical power, which has been tested and reported to have given good results. On an average, it may be stated, that the cost of lines for animal-worked trams has been £7,200 per kilometre, whilst for mechanical traction the lines of the Loire and St. Etienne cost only £6,000, those of the Nord from £3,280 to £3,440, and of the Sarthe £2,640 per kilometre. A comparison of the costs of working of the animal and mechanically drawn tramways is still more favourable to the latter. An examination of the detailed accounts shows the Parisian animal-drawn trams use up on the average for all lines about 90 per cent. of the gross receipts, whilst over the whole system where animal power is in use the average may be taken at 80 per cent. Grounding its opinion on the statistical proof of the superiority of the return from the tramways using mechanical power—and admitting that electricity may be requisite in Paris itself—the *Journal des Transports* hopes for a considerable extension of its use instead of animal force, and regards inter-urban communication of this kind as the most likely to afford immediate profits.

The Operative Electricians' Union.—A crowded meeting of the *employés* of electric lighting, telephone, and telegraph companies was held on Saturday night at Albion Hall, London-Wall, in support of the newly-formed Operative Electricians' Union. The chairman (a London electrical operative) explained that at a recent conference held in London of 300 men employed in telegraphy (mostly in the service of railway companies), electric lighting, and the telephone industry it was decided that it was quite time a trade union should be formed, not for aggressive purposes, but for the protection of the interests of the immense and constantly increasing number of workers in all branches of electricity. It was intended to have an organisation for the whole of the kingdom, based upon the most approved trade union lines, and governed by one code of rules hereafter to be determined by a representative conference. The movement had originated at Manchester, and was spreading to Liverpool, Glasgow, and most large provincial cities and towns. Mr. J. Rowlands, M.P., who had been invited to address the meeting, said he understood there were in London alone 3,000 operative electricians of various kinds eligible as members of their union, and he hoped they would all join it. Their industry, which was of comparatively new growth, was likely to be the great industry of the near future, and it behoved them as prudent men to have an association for the protection of their legitimate and just interests. He did not know whether they had any grievances to complain of, but if they were satisfied with their present remuneration they would be better able to maintain it by their organisation. He counselled them to have nothing to do with "outsiders" in the control and management of their affairs, but to select the best men from amongst themselves to form the executive of their union. He advised an amalgamated society of all branches of their trade for the entire kingdom, and suggested that they would do well to see how far they could profit by following on the lines laid down by the best managed and most successful of existing trade unions. The meeting pledged itself to support the new union, and most of those present who had not already joined enrolled themselves as members.

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A COMPARISON BETWEEN THE CONTINENTAL, AMERICAN, AND ENGLISH DYNAMO-ELECTRIC MACHINERY.

BY ALBION T. SNELL.

The following paper has been suggested by a visit to the Paris Exhibition. It is not intended to strictly confine the comparison to machines exhibited there, however; for, by so doing, the bulk of the English machines would be *hors concours* by reason of their absence. Yet, the greater part of the American, and the whole of the Continental firms referred to, are represented in the "Exposition."

It is in the domain of heavy electrical engineering that one is most impressed with the progress made on the Continent. Within the confines of the Exhibition there are no less than six central stations distributing power and light, and each counts its horse-power by the hundred. The "Société pour la Transmission de la Force par l'Electricité," the "Compagnie Continentale Edison," the "Société Alsacienne," the "Société Gramme," Messrs. Steinleu & Co., and the Oerlikon Company have all large plants for power and light. The aggregate power is probably more than 3,000 indicated horse-power. These installations are small compared with many in various towns, but regarded as exhibitions they are sufficiently remarkable. Owing to the fact that a large portion of the output is used for electrical transmission of power, the dynamos are chiefly of the direct-current type. Indeed, the brake horse-power of the electric motors, running in the different courts, is probably in excess of the total electric-motor power of Great Britain. That electric transmission of power does not seem to make much progress at home is an unfortunate fact, probably explained by the low price of gas and coal, and the absence of suitable water-power in most of our manufacturing centres.

English engineers will thus do well to study the power plants as exemplified at the Exhibition. There are many points developed by the extended practice of the Continental electricians, and much may be gained by an unprejudiced examination of the general details.

Broadly viewed, the Continental dynamos and motors are of sound design. Theoretical principles are properly appreciated, and the mechanical construction shows engineering of the highest order, though not always in accordance with our notions. In most cases, too, a sense of the beauty of proportions is evident, many of the designs being even elegant. Metal is used in the right place, as a rule; and, with few exceptions, the winding and other details are well carried out. To this general criticism some exceptions may be made, and very big ones too; but, on the whole, the dynamos compare very favourably with those in the English and American markets.

Generally there seems to be a tendency towards multipolar direct-current machines on the Continent: witness the Oerlikon (*Electrician*, July 19, p. 270), Thury-Alioth (*Electrician*, August 23, p. 397), Marcel-Deprez, Jaspar and Henrion exhibits.

In England, with the exception of the Brush and Gülcher Companies, and Messrs. Elwell-Parker in their larger dynamos, the two-pole type seems to be most favoured. I think, however, not always wisely. There seems to be a certain maximum width of pole which gives the best results for a given weight of material. Without entering into a theoretical discussion, I believe that practice has shown this to be the case. Indeed, my own experience points in this direction, and a careful comparison of weight efficiencies of a few large machines will justify the statement.

The "Continentale Edison," the "Société Gramme," and the "Société Alsacienne," however, use large two-pole machines, with single magnets. The Edison Company's machines have drum armatures and wrought-iron magnets with the cores and yoke above the armature. This form of field is similar to that originally adopted by Edison, but the modern forms, however, all embody the improvements suggested by Hopkinson with reference to length and cross-section of the cores. The chief advantage of this type of field would seem to be the small quantity of copper required in the windings. There are several disadvantages inherent to the single horse-shoe magnet, and these increase in their relative effect as the dimensions of the machine are increased. Primarily, there is a tendency to irregularity of distribution of the magnetic flux, causing a pull on the armature in the direction of the yoke. There is also a difficulty through heating with large armatures working with high magnetic densities, such as usually obtain with two-pole machines, about 16,000 to 18,000 C.-G.-S. units. Better results will be given by multipolar fields and lower densities.

With very large machines this inequality of field may assume such proportions as to render it practically impossible to keep the bearings cool, unless special precautions are taken. The Edison type of single magnet is the least affected by this, since the weight of the armature is against the attraction produced by the unequal field. This evil can also be counteracted to some extent by placing the armature excentric to the bore of the pole-pieces. A drum armature will give better all-round results in such a field than the ring type, since the field distortion will be generally less.

The Alsacienne machines (Fig. 1) are of the drum type, with the single field inverted, *i.e.*, the yoke is formed in the bed. As might be expected, the difficulty mentioned above appears here with greater force, for the weight of the armature is acting in the same direction as the distortion of the field. The result is a more or less heavy strain on the bearings. It is not surprising to find that the company have found this so, and have only overcome the difficulty after some considerable experimenting. In one case they found the downward pull on the shaft amounted to 1,500lbs.

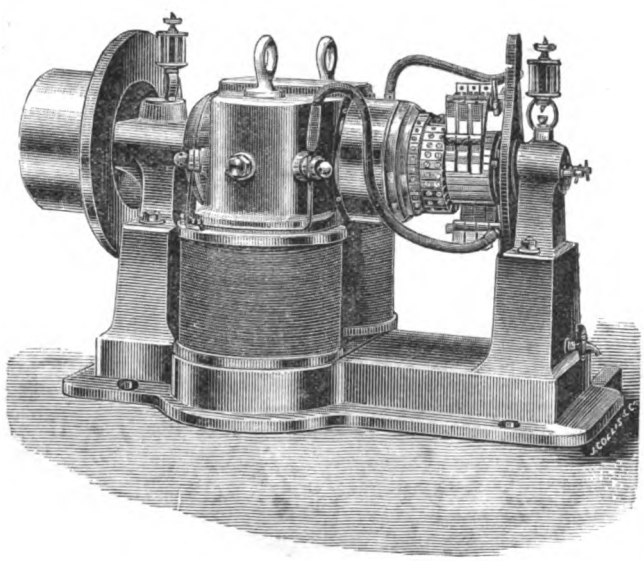

FIG. 1

I have myself seen a 3½in. shaft deflected $\frac{1}{16}$th of an inch in such a field. The Alsacienne engineers have overcome this difficulty by making massive pole-pieces with wrought-iron cores, thereby increasing both the cost and weight of the machine.

Messrs. Paterson and Cooper have built a number of machines of this type, but I believe they have not exceeded 16in. for the diameter of the armatures. The "Kapp" dynamo is also built on these lines.

The Gramme Compagnie have, perhaps, still more unfavourable conditions to contend with. They have the inverted single magnet and a ring armature. They overcome the downward strain by wrought-iron pole pieces bolted to the inside of extensions of the cast-iron magnet cores. Probably the armature is excentric to the pole-pieces, *i.e.*, the centre of the shaft is raised above the median line of the field-bore. Messrs. Siemens and Halske, of Berlin, have also made machines of the inverted single magnet type, but I do not know with what success.

In judging the relative merits of a design, one must not be content with the bare statement that the type runs successfully. Any motor, and nearly any dynamo, will run, and

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with proper management may generally be made to run well. The questions to be especially considered in forming an opinion are cost of production, including weight efficiency, durability, and cost of maintenance.

In England some of the disadvantages of the Edison type of machine are got over by using a frame-shaped bed with the pole-pieces sunk into the centre hollow and secured against brass distance pieces. The armature is thus very low down, nearly half being below the top of the bed. The drum type finds general approval for this class of dynamo. Machines of this type, with various modifications, have been built by Messrs. Latimer Clarke, Crompton and Co., and Messrs. Siemens Bros. They seem to be chiefly used for central station work.* With armatures of medium size there would appear to be little objection to this type; but with large armatures, say 24in. in diameter, I expect the field would be unequally distributed and cause trouble. The weight efficiency is probably raised above that of the other single magnet types.

For large two-pole machine a double field-magnet is preferable from some points. The distribution of magnetism in the armature is more regular, and there is some gain in weight efficiency. Machines of 50,000 watts and upwards have been built on these lines by Immisch and Co. (Fig. 2) for transmission of power in mines, and also for lighting and charging accumulators. Messrs. Mather and Platt have also identified themselves with this design in their well-known "Manchester" (Fig. 3) dynamo. Numerous other makers in England, America, and the Continent have also adopted this type. (In general all these machines have a very large waste field, which, though of no practical importance in most cases, is inadmissible for ship lighting. A single magnet with the armature sunk into the bed, as in the "Westminster" machine, is the least likely to give trouble aboard ship.)

But, on the whole, I do not think that large machines of the two-pole type would give such good all-round results as can be obtained from multipolar machines, especially if these latter have disc armatures. It seems remarkable that disc armatures have not found more favour for continuous-current machines. They answer admirably for alternating generators, and for synchronous motors. They are light, not exceptionally difficult or costly to construct, and are capable of a very large output per pound of material. If very large continuous-current dynamos are in demand, I expect the near future will see disc armatures of large diameters, with massive stationary magnets. The difficulty attending the coupling of the coils is not insurmountable. As a step in this direction, I may cite the short cylinder armatures of large diameter used in the Victoria and Gülcher dynamos, and more recently in a similar type by Messrs. Ernest Scott and Co. (see *Electrician*, October 4, p. 547). These machines all have shrouded pole-pieces. The above-mentioned advantages do not appear to be very apparent with the smaller sizes: indeed, my own experience points to a diminution of output. The ordinary cylinder or drum seems to give the better results for small outputs. I have never heard of a very large armature of this type—say, with 12 or more poles, and a very narrow core—but I expect the results would be very satisfactory.

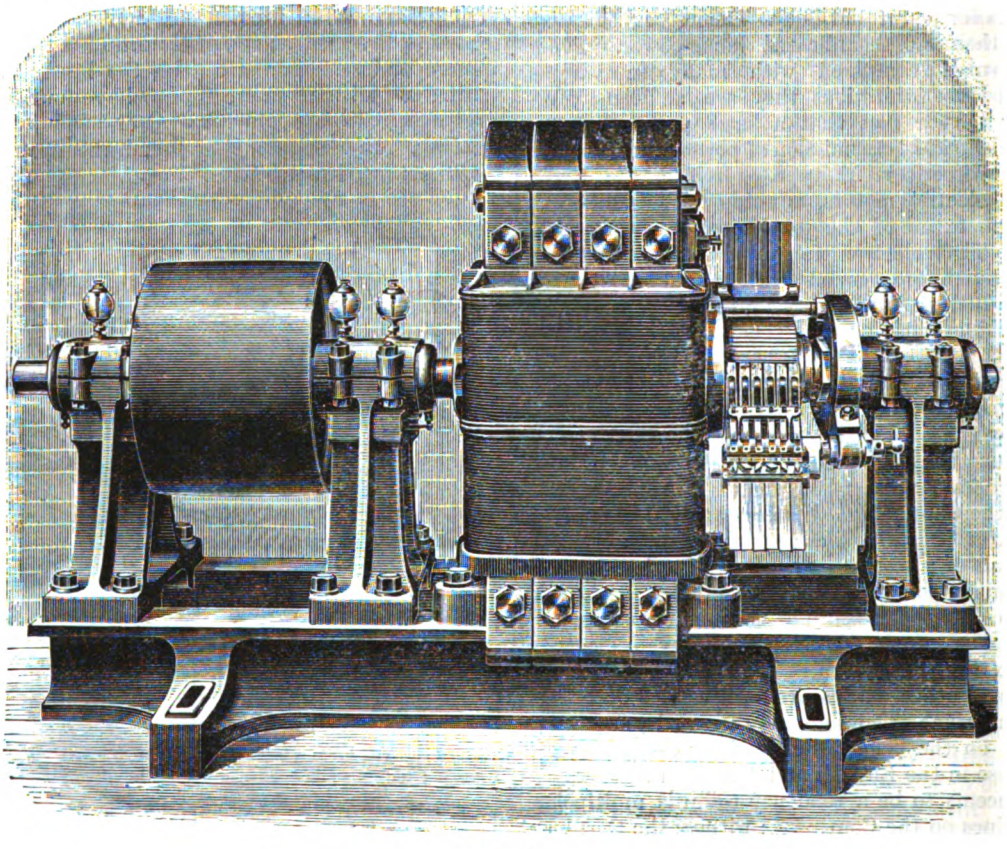

FIG. 2.

The Desrozier dynamo (Fig. 4) is an illustration of the more complicated disc armatures. It contains no iron. The method of winding the coils in two separate discs is open to criticism, and the results obtained do not seem to justify the complications involved. Though the makers claim a very large output, it seems more than probable that as good a result could be obtained with the more simple disc armature of the Thury or Edison type, whilst the difficulty of construction and of after repairs would be materially lessened.

Disc armatures for direct-current machines usually involve complications in the connections when compared with the ring or drum types. This is probably the reason why they have not come into more general use. The advantages of the disc type are undoubted for large armatures. The weight of the moving part is comparatively little, and the cooling surface is greater than that of any other design. The construction is simple if the ring winding be adopted, with a core of iron wire or ribbon. Perhaps the chief drawback lies in the balancing of the finished armature. The Henrion dynamos are of this type, being a development of the old Schuckert machine. I

* The Bradford and the Kensington Court Central Light and Power Stations have both dynamos of this type. They appear to be excellent machines.—A. T. S.

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expect to hear more of machines of this type for central station dynamos of large outputs.

The Société Alsacienne have a design for dynamos of very large outputs (Fig. 5). The field-magnets are star-shaped, and are placed inside a narrow ring armature. The commutator is built on the outside of the armature windings. This design is not new. I believe Messrs. Siemens and Halske have built similar dynamos. The makers claim that this arrangement shortens the magnetic circuit. Certainly the length of the yoke is re-

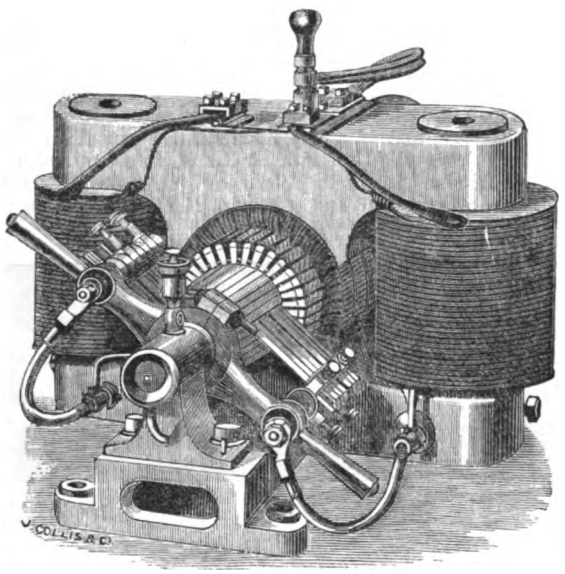

FIG. 3.

duced to a minimum, also the peripheral velocity of the conductors is a maximum for a minimum armature speed; but one would like to have more experience of the working of these dynamos before forming an opinion. The weak points in the design appear to be possibly too weak a field and certainly considerable expense in the commutator details. The construction

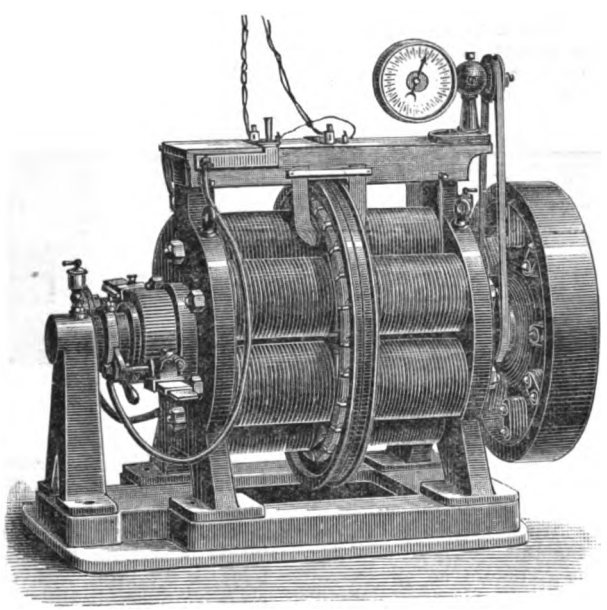

FIG. 4.

of the armature also involves apparently some difficulty. The good features that strike the casual observer are the low speed, compactness, and high weight efficiency. One of these machines running in the Galerie des Machines is coupled direct to an Armington and Sims engine of 150 horse-power. The dynamo weighs about 7 tons, and at 150 revolutions per minute gives normally an output of 1,000 amperes and 125 volts. The surface velocity of the *commutator* at this speed is about 2,800 feet per minute, so that the output can be safely considerably increased. The makers state that it will give about 1,500 amperes and 200 volts, or 300,000 watts, without undue strain or over-heating.

If the safe output be taken at 200 kilowatts, the weight per electric horse-power is approximately 58lb. At 125 kilowatts output, every 92lb. of material gives 1 electrical horse-power. I think this machine has the highest weight-efficiency of any large dynamo in the Exhibition. Allowing the same rise of temperature, a two-pole single magnet machine would certainly weigh 10 to 12 tons for a similar output; and a multipolar field, with a cylinder armature, would be scarcely less than 10 tons. Only a disc armature, with multipolar fields, could compete as regards weight. It is doubtful, however, whether this type of dynamo will come into general use. Weight efficiency is not essentially a criterion of commercial efficiency, and probably the multipolar types, with *inside armatures*, are not only cheaper, but also more reliable in practice.

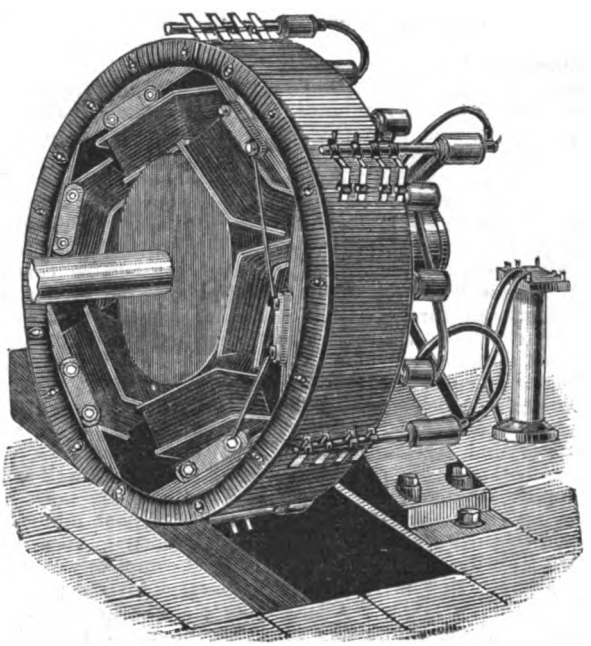

FIG. 5.

I have discussed these different types at length, in a general way, in order to emphasise the advantages of a large diameter armature, with a low magnetic density, a high peripheral speed, and a low speed of shaft. These seem to indicate the correct lines on which to design the large central station dynamos and motors which are likely to be in considerable demand in the immediate future.

(To be continued.)

ELECTRIC TRAMWAYS IN BIRMINGHAM.

The public trial of one of the storage cars to be used on the Bristol Road route took place last Wednesday. Upon drawing up in Station-street the car was immediately loaded with between forty and fifty passengers, amongst whom were the Mayor of Birmingham (Alderman R. C. Barrow), several members of the Corporation, Sir Douglas Fox, Sir Daniel Cooper, and Sir Saul Samuel, Agent-General for Australia. Besides these the number of engineers, electricians, and members of public bodies anxious to witness the trial was so great that the electric car had to be attended during its run by a large steam tramcar to carry the "overflow."

The car was not tried on the route upon which it is destined to run, but on the track where the formidable incline in Bradford-street has to be surmounted. This is about one-third of a mile long, with a gradient of 1 in 17 in one part. It was not attempted to ascend the Bradford-street hill at the same speed

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as the steam-trams, the favourite device of the drivers of the latter being to "rush" it. The car, however, went steadily up without pause or hitch, and soon caught up its rival on reaching the level. Notwithstanding its momentum the car was several times pulled up in its own length on falling gradients.

By the use of automatic contact connections the accumulators can be changed in five minutes. The motor gear is fixed beneath the car on the front bogie truck, thus leaving the entrance to the car clear at either end The ease with which the car negotiated "points" and rounded sharp curves left nothing to be desired.

As the Bristol Road route is nearly free of gradients and curves, and has just been relaid with a new track, the new cars will come into operation under unusually favourable conditions.

A NEW FORM OF GAS BATTERY.

BY LUDWIG MOND AND CARL LANGER.*

In January, 1839, now over fifty years ago, Mr. (now Lord Justice) Grove published the first notice of his startling discovery—the gas battery. Since that time very little attention has been given by investigators to the subject. This is the more surprising as Grove had published a large number of experiments leading, amongst other important results, to a complete list of the voltaic relations of gases to each other and to other substances, and had pointed out in his lucid manner the great scientific interest attaching to the gas battery, which forms the simplest instrument for generating electricity, possesses remarkable constancy of E.M.F., and "exhibits such a beautiful example of the correlation of natural forces." Grove states that he never thought of the gas battery as a practical means of generating voltaic power, but, nevertheless, he indicates clearly in what directions improvements with this object should be attempted, viz., by extending as much as possible the surface of contact between the gases, the absorbent and the electrolyte. We have been engaged for several years with investigations on gas batteries, which fully corroborate Grove's view, but show that he, as well as later investigators, overlooks one important point, viz., the necessity of maintaining the condensing power of the absorbent unimpaired. We found that platinum black, the most suitable absorbent for gas batteries, loses its condensing power almost completely as soon as it gets wet, and that it is therefore necessary for our purpose to keep it comparatively dry. All attempts to attain this with various constructions of the gas battery involving the use of a liquid electrolyte failed. We have only succeeded by using an electrolyte in a quasi-solid form, viz., soaked up by a porous non-conducting material, in a similar way as has been done in the so-called dry piles and batteries.

In order to procure as large a contact as possible between the gases, the electrolyte and the absorbent, and at the same time to obtain the greatest possible duty out of a given quantity of the latter, we have adopted the following construction :—A diaphragm of a porous non-conducting substance, such as plaster of Paris, earthenware, asbestos, pasteboard, &c., is impregnated by dilute sulphuric acid or another electrolyte, and is covered on both sides with thin perforated leaf of platinum or gold and with a thin film of platinum black. The platinum or gold leaf, which serves as conductor for the generated electricity (the platinum black being a very bad conductor) is placed in contact at small intervals with strips of lead or other good conductor in order to reduce the internal resistance of the battery to a minimum. In place of the platinum or gold leaf, fine wire gauze of the same metal or of carbon may be used. The diaphragms so prepared are placed side by side or one above the other, with non-conducting frames of pasteboard, wood, india-rubber, &c., intervening, so as to form chambers through which the gases to be employed (generally hydrogen and air) are passed, so that one side of the diaphragm is exposed to the one gas and the other to the other gas, and the spaces between the diaphragms are so connected that these gases pass in contact with a number of diaphragms. Of the numerous ways in which dry gas batteries can be constructed we will describe two. One of these constructions, suitable for laboratory work, shown in Fig. 1, consists of an earthenware plate, M, impregnated with sulphuric acid and cemented into an ebonite frame, R. At a short distance from and all around the plate a copper wire, A, is let into the ebonite frame. The earthenware plate is covered with platinum leaf, which has been perforated with a very large number (1,500 per square cm.) of small holes, and which extends over and is in metallic contact with the copper wire. To protect the latter from corrosion, and to avoid local action, molten paraffin is put over the platinum leaf where it is in contact with the copper wire. Where the platinum leaf is in contact with the earthenware plate it is coated by means of a brush with a very thin film of platinum black, which penetrates through the pores and holes of the platinum leaf, and thus comes into contact with the electrolyte. The frame R is fixed by means of screws between the two ebonite plates, E, E', with two india-rubber frames, K, K', intervening, thus forming two gas-tight chambers, G, G', through which the gases to be used are let by the tubes O, O' and H, H'. The second construction, Fig. 2, consists of a number of elements, each of which is composed of two frames of lead and antimony, consisting of a broad edge, R, conducting strips, A, and flaps, F, with holes and channels, O. H, which form the inlets and outlets for the gases. These frames are coated with an insulating layer, a, of a mixture of gutta-percha, beeswax, resin, and paraffin. Between the two frames we insert a thin sheet, S, prepared by coating a piece of cloth with plaster of Paris, and made impervious round the edges by the same insulating mixture, and then the open spaces formed by the conducting strips A are filled up with plaster of Paris, mixed up with dilute sulphuric acid, so as to obtain an even plate. This is now coated with platinum leaf and platinum black in the same way as

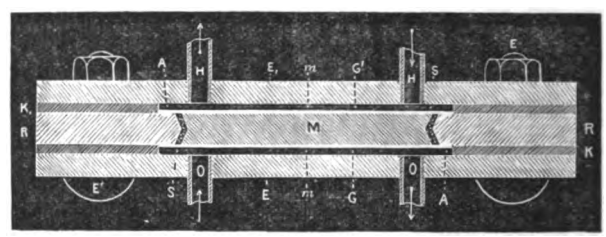

FIG. 1

before described. A number of these elements are put side by side, or one above the other, with non-conducting frames, K, of pasteboard intervening, so as to form gas chambers, G_1, G_2, G_3, which are connected by means of cork or rubber washers, Q, so that the gases admitted by the pipes O pass through the whole series of chambers. The first and the last gas chamber are formed by an additional pasteboard frame intervening between the last plates and two plates of zinc, Z_1, Z_2, extending beyond the battery plates, which hold the set together. The whole set of plates is now coated on the four sides not covered by the zinc plates with a mixture of beeswax and resin, so as to obtain a block which is perfectly gas-tight all round, and the space V left between the two zinc plates is then filled up with plaster of Paris, so as to obtain one solid compact block with no openings except the entrances and exits for the gases. This is closed by four more zinc plates, Z_3, Z_4, Z_5, Z_6, which are soldered together so as to form a box.

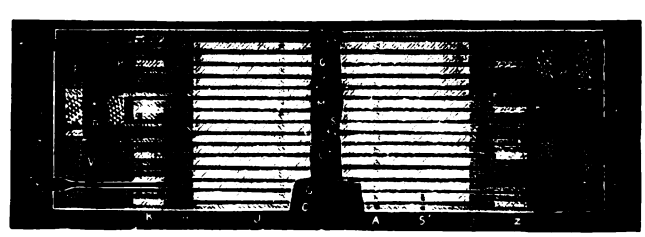

FIG. 2

The E.M.F. of this battery we found to vary considerably, according to the way in which the platinum black is prepared. The best and most regular results we have obtained from platinum black made by neutralising a boiling solution of $PtCl_4$ with Na_2CO_3, and adding this slowly to a boiling solution of sodium formiate. With this we obtain an electromotive force of 0·97 volt with the open circuit. The internal resistance varies considerably with the thickness of the porous plates, the amount of the electrolyte contained in these, and the surface of these plates. Plates of gypsum of 8 mm. thickness and 350 cm. surface gave an internal resistance of 0·02 ohm.

The current obtainable from these batteries varies necessarily with the external resistance. It is possible to obtain eight amperes from one such element, but the E.M.F. of the battery sinks at a very much more rapid rate than with constant batteries if a strong current is taken out, and the work done by the battery is not, as in constant batteries, at its maximum when the internal and external resistance are equal. Thus we found with a small battery of 42 sq. cm. surface and 0·36 ohm internal resistance the following results :—

* Abstract of Paper read before the Royal Society, June, 1889.

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R.	R_1.	P.	S.	E.	E_1.	D.	A.
0·360	0·30	0·265	0·883	0·62	0·58	0·04	0·236
„	0·40	0·310	0·775	0·62	0·58	0·04	0·240
„	0·70	0·430	0·614	0·67	0·65	0·02	0·263
„	1·00	0·490	0·490	0·68	0·66	0·02	0·240
„	2·00	0·605	0·302	0·72	0·71	0·01	0·219
„	4·00	0·700	0·175	0·77	0·76	0·01	0·122
„	8·00	0·780	0·097	0·81	0·81	0·00	0·075
„	20·00	0·860	0·043	0·87	0·87	0·00	0·036

R. Internal resistance in ohms; R_1. External resistance in ohms; P, Difference of potential at the poles; S. Strength of current in amperes; E. E.M.F. in volts, determined by the first deflection of the galvanometer needle one second after opening the circuit; E_1. Calculated E.M.F. in volts; D. Difference of E and E_1 = increase of E.M.F. during one second, showing rapidity of absorption of the gases with varying saturation of the platinum; A. Work done by the battery in watts.

These figures show that in the case of the battery experimented with the maximum of work was obtained with an external resistance of about double the internal resistance. This result is probably due, as pointed out by Dr. C. A. Wright,* to the fact established by Favre† and Berthelot,‡ that the gases occluded or condensed by platinum black evolve less and less heat per unit weight of gas the more gas the platinum black had previously condensed. The heat evolved by the condensation of the gases by the platinum black, or a certain portion of this heat, is in all probability lost for the production of the current; it follows that the more the platinum black is saturated the less energy will be lost by the condensation of the gases, and *vice versa*. Now, probably the rate of absorption of gas by the platinum black will rapidly diminish as it is more and more saturated with gas, so that in order to maintain it saturated or nearly saturated only a moderate amount of current can be obtained from a given surface, while if it is kept far below the saturating point it will condense the gases very rapidly, and a very large current can consequently be obtained.

As a practical limit we prefer to work the battery with an E.M.F. with closed circuit of about 0·73 volt. This allows us to take from 2 to 2½ amperes (1·45—1·82 watt) out of an element with an active surface of 700 sq. cm., covered with 0·35 gr. of Pt leaf and 1 gr. of Pt black, which gives a useful effect of very nearly 50 per cent. of the total energy contained in the hydrogen absorbed in the battery. We have found practically no difference in these results, whether we were using O and H or air and gases containing 30 per cent. to 40 per cent. of H, such as can be obtained by the action of steam or air and steam on anthracite, coke, or coal. With a useful effect of 50 per cent., one-half of the heat produced by the combination of the H with the O is set free in the battery, and raises its temperature. By passing through the battery a sufficient excess of air, we can keep the temperature of the battery constant at about 40° C., and at the same time carry off the whole of the water formed in the battery by means of the gases issuing from it, so that the platinum black is kept sufficiently dry, and the porous plate in nearly the same state of humidity.

The E.M.F. of the open battery is very considerably below what it should be according to Thomson's theorem. The combustion of H and O should produce an E.M.F. of 1·47 volts, while we only obtain 0·97. It does not seem to us probable that this difference can be explained in the same way as the deviations from this theorem in a number of abnormal voltaic batteries have lately been explained by Chroustchoff and Sitnikoff,§ viz., by the Peltier effect, which would probably not be different for the combinations HPt,SO_4H_2 and SO_4H_2,PtO; nor do the causes by which Herroun‖ explains this deviation appear to us to be applicable to the gas battery. It seems more probable—and what we have stated above respecting the rapid loss of the E.M.F. when taking out larger currents favours this view—that this loss of energy is to some extent due to the heat given out in the condensation of the gases by the platinum black.

In the hope of throwing some light upon the question of the disappearance of energy in the gas battery, we determined the E.M.F. of various combinations by means of a block of plaster of Paris impregnated with sulphuric acid, one end of which was covered with platinum foil and platinum black, and arranged so that it could be exposed to H or O, while the other end was plunged into a beaker which contained the liquid electrolyte and the electrode which we wished to examine. The results show that the loss of energy is very nearly the same per equivalent of O consumed, when PtO is used as the negative electrode, whether PtH, zinc, cadmium, or copper is used as positive electrode, and also that PtH with copper in copper sulphate, or carbon in nitric acid, as negative electrodes, gives nearly the theoretical E.M.F. It would thus seem as if the loss of energy in the gas battery occurred on the PtO electrode; but the question is undoubtedly a complicated one, and requires further study before an explanation of it can be attempted.

This battery differs from all other gas batteries in showing all the characteristics of polarisation after it has been at work for some length of time. It loses within an hour from 4 to 10 per cent. of its E.M.F. As the chemical processes taking place at the electrodes could not explain this, we had to look out for its cause in another direction, and found it to be the transport of the sulphuric acid from the O to the H electrode, resulting in the acid becoming gradually more concentrated on the positive side and weaker on the other, which we have established by analysing the gypsum scraped off below the platinum leaf at both sides. Probably this difference of concentration of the acid sets up a counter-current. In order to counteract this disturbing influence and to keep the current constant, we interchange the gases in the battery from time to time—say once an hour—so that the current goes in an opposite way through the porous diaphragm, and transports the sulphuric acid back. This necessitates, where constant currents are wanted for a longer period, the working of a number of elements or batteries connected by means of a commutator in such a way that one element or battery will always be out of the circuit, and have its gases changed, and be replaced in the circuit at the moment when the next element or battery is switched out for the same purpose.

In using, in place of sulphuric acid, a solution of sodium chloride as electrolyte, we found, after working the battery for some time, sodium hydrate on one side and HCl on the other side of the battery, and have been able to determine in this case the polarisation to be equal to 0·54 volt, which very nearly accounts for the difference between the E.M.F. of the open battery and the E.M.F. calculated according to Thomson's theorem. The E.M.F. of PtH,NaClAq,PtO we found equal 0·86 volt, which, added to the polarisation of 0·54 volt just mentioned, gives a total of 1·40 against the theoretical figure for H, O = 1·47. By changing the gases after the polarisation was fully established, the battery showed an E.M.F. of 1·39 volts. This observation, as well as the determinations of Peirce,* of the E.M.F. of gas batteries with the same gases and different electrolytes, shows that the electrolyte also has considerable influence upon the E.M.F.

We hope by further investigation to arrive at assigning their proper value to the various causes affecting the E.M.F. of gas batteries.

* *Phil. Mag.*, Vol. IX., 1881, p. 169.
† *Comptes Rendus*, Vol. LXXVII., 1873, p. 649.
‡ *Annales de Chimie*, Vol. XXX., 1883, p. 519.
§ *Comptes Rendus*, Vol. CVIII., 1889, p. 987.
Phil. Mag., Vol. XXVII., 1889, p. 209

* Wiedemann, *Annalen* Vol. VIII. 1879, p. 98

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(To night) FRIDAY, November 1st.

PHYSICAL SOCIETY.

5 p.m. "On Electrifications due to the Contact of Gases with Liquids." By J. ENRIGHT. "On a New Electric Radiation Meter." By W. G. GREGORY, M.A. "On a Physical Basis for the Theory of Errors." By C. V. BURTON, D.Sc.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the St. James's Hall Restaurant.

MONDAY, November 4th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ENGINEERS.

7:30 p.m. Paper to be read, "Modern Gas Engine Practice." By SAMUEL GRIFFIN.

INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Dinner at the Criterion Restaurant, Piccadilly.

TUESDAY, November 5th.

ROYAL VICTORIA HALL.

8:30 p.m. Lecture "Dust." By A. P. LAURIE.

THURSDAY, November 7th.

CHEMICAL SOCIETY.

8 p.m. Papers to be read: "The Isolation of a New Hydrate of Sulphuric Acid existing in Solution." By S. U. PICKERING. "Further Observations on the Magnetic Rotation of Nitric Acid, of Hydrogen Chloride, Bromide, and Iodide in Solution. By Dr. W. H. PERKINS, F.R.S. "On Phosphoryl Trifluoride." By T. E. THORPE, F.R.S., and F. T. HAMBLY. "On the Acetylation of Cellulose." By C. F. CROSS and E. BEVAN. "On the Action of Light on Moist Oxygen." By A. RICHARDSON. "Anhydracetophenone Benzil and the Constitution of Linius Lepidens." By Drs. JAPP, F.R.S., and KLINGEMAN.

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The Electrician.

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The present number of "THE ELECTRICIAN" completes Volume XXIII. With next week's number will be issued the Index to the Volume.

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ELECTRICITY IN MINES.

It is a somewhat remarkable fact that Great Britain, with her output of over 150,000,000 tons of coal per annum, has as yet availed itself only to a very limited extent of the enormous advantages resulting from electric lighting and transmission of power in mines. No doubt a good many mines, especially in Wales, are lighted by fixed glow lamps, and the number of portable electric miners' lamps in use in our pits is steadily increasing; but in comparison with the enormous field for its application, the total of electric lighting done in mines is still insignificant, and as regards transmission of power the case is yet more unfavourable. A few pumping and hauling plants, and a few coal-getting machines, is all we have to boast of; but these few machines and plants do their work so satisfactorily that duplicate orders almost invariably follow. Those few mine-owners and managers who have tried electric-power transmission want more and more of it, and are discarding their old plant for the new system with perfect confidence. But why have so few tried it, and why do not more follow the example set them by their enterprising neighbours? We fear that in this respect both the electrical and the mining engineers are to blame. The former, as a rule, know nothing of mining and its requirements, whilst the latter know about as much of electricity and its capabilities. The general run of mining engineer is a rule-of-thumb man, accustomed to rough and heavy work, and

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not given to bother his head much about elegance of design, perfect workmanship, or high efficiency of the machinery he employs. Coal is cheap at the pit's mouth, and as long as his hauling gear, pumps, and other machinery can be kept going somehow without a break-down, he is satisfied to let things remain as they are. The electrical engineer has thus no easy task in persuading him, first, that the plant which he has been in the habit of using for generations is capable of improvement; and next, that electricity is the agent which alone renders this improvement possible. This difficulty is all the greater because the average electrical engineer is too much of an electrician, and too little of an engineer; to say nothing of his total ignorance of mining work. Before we can hope to see our coal mines become a profitable field for the employment of electric power transmission, both the mining and the electrical engineer must pass through a course of education—not such a course as is provided in our technical colleges, but such a one as actual practice and the close study of what has already been done in that direction alone affords.

Viewed in this light, the lecture which Mr. ALBION T. SNELL recently delivered in the Mining School at Wigan, and of which we printed an abstract in our last issue, is of considerable importance. In this lecture Mr. SNELL brought before his audience a plain statement of what had been done with electric power transmission in some of the hauling and pumping plants with which he had been connected. In one case, that of the Normanton plant, comparative tests were made between pneumatic and electric transmission of power, and the results will come as a startling revelation to those who, influenced by Prof. KENNEDY'S able Paper on the Paris Compressed Air-Power Supply, read before the last meeting of the British Association, were beginning to again lean towards a system of transmitting power which has over and over again been proved to be uneconomical. Mr. SNELL did not speak as if he held a brief for electric transmission, but simply stated facts, allowing them to speak for themselves. Had he chosen he might have made out a very much stronger case against pneumatic and for electric transmission than he actually did. He might have pointed out that the difference in efficiency (12 to 14 per cent. with pneumatic, against 43 to 44 per cent. with electric transmission) was, as far as the coal bill went, really the least important part of the comparison; that the importance lay in the necessity of putting up a boiler and engine about three times as large to do the same work; that the cost of the compressors and motors considerably exceeded that of dynamos and motors; that the cost of attendance was also greater; and last, but not least, that the cost and trouble of keeping in order the air pipes in workings which are continually shifting, was many times greater than the corresponding items when a cable is used. Our electrical readers will, perhaps, be astonished to learn that in many cases the air main must be provided at every twelve feet or so with a ball-and-socket joint, or other flexible connection, and that where the distance is at all considerable the capital outlay for this air main alone exceeds that for dynamos, leads, and motors. The comparatively high efficiency which Prof. KENNEDY obtained in his experiments at Paris, where the air motor which he tested was in the same building with the air compressors, and where, consequently, losses by leakage were excluded, is, for this, and another reason to which we shall presently refer, quite unattainable in mining work. To keep the flexible air main absolutely tight is obviously impossible, and a loss of power by leakage is, therefore, a necessary evil. Whether the Paris air mains are tight is a question which need not concern us here, but it is certain that the motors considered by themselves must have a higher efficiency than air motors employed in a colliery. The reason is simply this, that above ground the power given out by the motor is considerably increased by heating the air before it enters the motor. The energy thus communicated to the motor in the shape of heat is credited to the whole system of transmission, and hence the efficiency becomes greater than it would otherwise be. If this principle be carried to its greatest extent the air becomes simply a convenient medium for the transformation of heat locally applied into mechanical energy; but this is not transmission of energy to a distance, it is conversion of one form of energy into another form on the spot. In a mine the application of heat to the air motor is clearly inadmissible, and hence the much lower efficiency as compared with air motors above ground. We have dwelt on this aspect of the case at some length to prevent any possibility of an unfair comparison between the results of Professor KENNEDY'S experiments and the figures given by Mr. SNELL. It might otherwise have been objected that the air motor tested at the Normanton Colliery was of bad design, and that this was the only reason why there the efficiency came out at 14 per cent., whereas in the Paris plant it came out at something approaching 40 per cent. Whether the motor was or was not inferior we do not pretend to say; this much is certain, that it could not have been so much inferior as to account for the whole of the difference in the efficiency, and that even were the motor as perfect as good workmanship and mechanical skill can make it, the efficiency of the whole air-power plant can never even approach that which is easily obtainable with an electrical plant.

Apart, however, from questions of first cost and efficiency, the electric power transmission has many other advantages. In describing the Llanerch Colliery Hauling and Pumping Plant, Mr. SNELL drew attention to the fact that the hauling power is under perfect control, and the trams can be moved a few inches at a time or hauled up the incline at full speed with equal certainty. Not only is the power under almost instantaneous control, but the engineman knows at any moment how much power his dynamo is giving off. He need only watch the ammeter to tell at a glance the number of trams on the rope, and if a derailment should take place or the progress of the trams be impeded by any obstacle, the needle of the ammeter will show this immediately, giving the engineman warning to switch off before any mischief is done. With compressed air power, this would obviously be impossible. The amount of attendance required underground is very trifling. In the Linlithgow Pumping Plant, for instance, the electro-motor and pumps are visited once a day by an attendant, who has simply to fill up the lubricators and may then leave the machinery to take care of itself. It need hardly be said that such admirable results are only possible with apparatus constructed in a very substantial manner. It is not to be expected that enginemen in a colliery will treat dynamos and motors with the gentleness and care generally bestowed on scientific apparatus. They are used to rough, heavy machinery, which will stand a good deal of ill-treatment, and the secret of success lies not in trying to educate men up to the level of professors, but to make the machinery strong enough, so that the men may deal with it in the rough manner to which they are accustomed. The other day we saw some electric coal-cutting machines, and complimented the maker on the very substantial design. "Yes," he said, "we are obliged to make our machines so strong that the men, if they be so minded, might adjust them with a sledge-hammer without doing any damage." In this sentence lies the secret of success. Let the electrical engineer design his machinery strong enough for the roughest usage, and the mining engineer will be ready enough to adopt it.

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OBITUARY.

M. LOUIS CURCHOD.

It is with great regret that we announce the death of M. Louis Curchod, Director of the International Telegraph Bureau, who died at Berne on the 18th October, after a long illness.

Born at Crissier (Switzerland) on the 7th October, 1826, M. Curchod completed his studies at the École Centrale des Arts et Manufactures de Paris, which he left in 1849 with the diploma of engineer. From that time he devoted himself to telegraphy, and soon accepted the post of Inspector in the Federal Telegraphic Service. His brilliant intelligence, his eagerness for work, and his technical knowledge soon brought him to the notice of the Conseil Fédéral, and he was appointed Director of the Swiss Telegraph Service. It was in this quality that he took part in the preparation of the first International Telegraph Conventions, which were entered into at first with the adjoining countries, and afterwards with most other European States. Charged with representing his country at the International Telegraph Conference held in Paris in 1865, he brought to bear the experience which he had acquired in organising the Swiss Telegraphs, and he rendered great assistance at this first meeting of the heads of the telegraphic system of Europe, among whom he immediately took the influential position he occupied until his death. The International Conference held in Vienna in 1868 gave him a fresh opportunity of displaying his remarkable administrative qualities. The formation of the International Telegraph Bureau, the management of which was confided to the Swiss Government, was one of the results of this Conference, and M. Curchod, who had taken great part in the creation of this new institution, was naturally the man to be appointed to the direction of it. To this office, from which he did not separate himself except for a short time when he filled the post of Managing Director of the Société du Câble Transatlantique Français, M. Curchod devoted all his time and all his energy. He took part in the work of the Telegraph Conferences of Rome (1871), of St. Petersburg (1875), of London (1879), and of Berlin (1885), and he contributed greatly to the work realised by these various Conferences, fulfilling with great distinction the *rôle* of adviser and conciliator whenever questions arose upon which opinions were divided. M. Curchod of course received numerous testimonies of the high esteem in which he was held by the Governments belonging to the Telegraph Union. He was Grand Officer of the Order of St. Stanislas, Commander of the Order of the Royal Crown of Prussia, Officer of the Legion of Honour, Commander of the Order of the Royal Crown of Italy, Grand Officer of the Order of Francis Joseph, &c., &c.

The void which M. Curchod's premature death has made at the International Telegraph Bureau will be difficult to fill.

THE PROPOSED NATIONAL MEMORIAL TO DR. JOULE.

The following letter from Sir Henry Roscoe appeared in *The Times* of Saturday:—

SIR: The scientific and also, I believe, the general public will learn with satisfaction through your columns that at the meeting of the Council of the Royal Society held yesterday, at which the lamented death of our illustrious Fellow was formally announced, it was unanimously resolved, on a motion proposed by myself, to appoint a committee to consider, and, if the proposal be accepted, to carry out, the erection of a national memorial to the late Dr. Joule.

The committee is one truly representative of British science. It consists of the presidents and officers of the Royal Society, and of several members of the Council and other Fellows. To these will be added, for of their consent and co-operation there can be no doubt, the presidents of many of the scientific societies and associations, as well as other influential representatives of those sciences to which the labours of Joule have added such lustre.

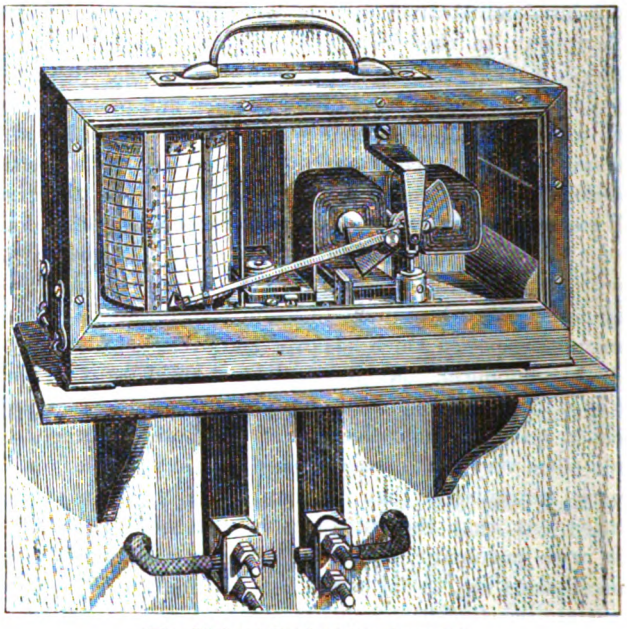
It is only proper that the Royal Society, representing as it does British science at once in its highest and widest forms, should take the initiative in promoting the national recognition of one whose services to science and to mankind are conceded by all scientific men to be only second to those rendered by Newton himself.

I am, your obedient servant,

October 25. HENRY E. ROSCOE.

THE RICHARD REGISTERING CENTRAL STATION INSTRUMENTS.

Amongst the fine show of instruments of precision exhibited at the Paris Exhibition by MM. Richard Frères are some useful registering ammeters and voltmeters, specially designed for central station purposes These instruments (*see* Figure) consist of a horse-shoe electro-magnet with an iron armature, in appearance not at all unlike a ship's propeller, which moves in close proximity to the poles, round an axis parallel to the two limbs of the magnet. The resistance of the magnetic circuit varies, therefore, considerably, according to the position of the armature, and is at a maximum when the pointer is at zero. The couple which acts on the armature when the instrument is in circuit is opposed by a weight hung at the end of a small lever. The instrument shown in the figure is an ammeter capable of measuring currents up to 100 amperes. By means of a long pointer a considerable amplification of the movements of the armature is obtained. To the end of this pointer a pencil is attached, and the value of the current at any moment is marked on the revolving drum, which is divided in the manner shown, and which turns at any desired speed. The



The Richard Registering Ammeter.

vertical graduated scale enables one to read off the current in the usual way whenever requisite. In some instruments the drum is replaced by an endless strip of paper unwound at the rate of three centimetres per minute. The ammeters absorb from 6 to 120 watts, according to their size (10 to 2,000 amperes). The voltmeters, which measure up to 120 volts, have 1,500 ohms resistance, and absorb 96 watts, they carry 2·5 kilogrammes of wire, and never heat to more than 8°C. about the surrounding atmosphere. These ammeters and voltmeters have been found to act as very efficient checks upon the watchfulness of central station attendants. It is possible also to use the current records as electricity meters, by simply cutting out the curve and weighing the lower portion of the paper.

NOTE ON THE EMPLOYMENT OF CHROMIC ACID INSTEAD OF NITRIC ACID IN THE BUNSEN CELL.*

BY J. WILSON SWAN, M.A.

Thanks to the initiative of Mr. William Rowell, of Newcastle, chromic acid is manufactured on a much larger scale than formerly, and its price is so reduced as to bring it into competition with the chromates of the alkalis, and with nitric acid as the depolarising agent in the Grove and the Bunsen cell.

* Paper read before the British Association in Section "A," Newcastle-on-Tyne, September, 1889.

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Ever since these cells were first used, a way of escape from the necessity of employing nitric acid has been continually sought, and, it must be admitted, with small success.

Where it was required to produce a large current for a short time, the Bunsen cell charged with a strongly acid solution of bichromate of potash instead of nitric acid has been used with good effect, but where a large current was required to be steadily maintained during several hours this substitution has proved to be wholly inefficient.

When, for example, the resistance of the cell so charged and the external resistance are about equal, it is very well known that there is an almost immediate and very large decrease of current. When chromic acid became an article of commerce at a moderate price, it seemed to me worth while to try afresh what could be done with it. Out of a great number of experiments (in which I have been assisted by Mr. Leigh Powell), I propose to bring before you the results of two, with a view to show, comparatively, the discharge of a Bunsen cell charged in the usual manner, and a discharge of the same cell similarly charged as regards the zinc compartment, but with a chromic acid mixture instead of nitric acid in the carbon compartment. The cell employed was of the Holmes Burke construction ; it consisted of two carbon and two zinc plates, a porous inner cell, and a vitreous earthenware outer cell. The carbon plates were in the porous cell, and the zinc plates outside it. The size of the plates was 9½in. by 7in., and as the two carbon plates were not far apart, only their outer surfaces would take any large part in the action of the battery.

To take advantage of the lower resistance of the cell at a high temperature, the heat generated by mixing the water and sulphuric acid was utilised. The discharge was commenced while the liquid was hot, and the cell was closely surrounded by a wall of sawdust three inches thick. Under these conditions the temperature was maintained during the whole time (13 hours) at between 90deg. and 120deg. F. The resistance external to the cell was adjusted to a quantity which was intended to be and which proved to be nearly the mean resistance of the cell itself during the time of discharge, and, therefore, the electromotive force available for external work was nearly one volt.

The diagram shows the curve in amperes of two discharges. The black line gives the curve of the discharge when the cell was used as a Bunsen, *i.e.*, with nitric acid in the porous cell, and the red line shows the discharge of the same cell with a mixture of chromic, sulphuric, and nitric acids substituted for the nitric acid. The composition of this solution was as follows :—

	Parts by Weight.
Nitric acid specific gravity 142	1
Chromic acid	3
Sulphuric acid	6
Water	5

It will be observed that the proportion of nitric acid in the mixture is very small. With this mixture there is no fuming such as occurs during the nitric acid discharge. It was found impossible to get the effect required without *some* nitric acid, but with this small proportion added to the large proportions of sulphuric and chromic acids, a depolarising effect was obtained practically equal to nitric acid. Several circumstances attending discharge with the chromic acid mixture suggests that the nitric acid in it, small as the quantity is, plays a chief part in the electrolytic action, and it is certain that without it a very inferior result is obtained.

The zinc compartment, in both experiments, contained three-fourths of a gallon of sulphuric acid and water of specific gravity 117deg.

The carbon compartment,

In the nitric acid experiment contained :—	In the chromic acid experiments contained :—
Three-eighth of a gallon of nitric acid, specific gravity 136.	Three-eighth of a gallon of the chromic mixture.

The diagram which was exhibited in connection with this Paper showed broadly that the chromic acid mixture was equal to nitric acid, with a large discharge extending over a long time. During 13 hours there was a drop in the current from 20 amperes at the beginning to 18 amperes at the end of the discharge. The chromic acid mixture in the carbon compartment, and also the dilute sulphuric acid in the zinc compartment, were both nearly exhausted in that time ; but in the case of the nitric acid discharge there was still a considerable further effect obtainable by renewal of the dilute sulphuric acid. The quantity of the nitric acid might, therefore, have been reduced without reducing the duration or quantity of the discharge.

In attempting to reduce the proportion of nitric acid in the chromic acid mixture to the smallest efficient amount, it was observed that there was a difference in the proportion required for carbon and for platinum, much more nitric acid being required to produce the kind of electrolytic action which sustained a large current, and in which there was at first and during a very considerable period of the discharge an entire absence of effervescence at the surface of the negative element, and towards the end a slight emission of nitrogen dioxide. With the chromic acid mixture employed in the discharge, described in the diagram, there was no emission of gas at the surface of the negative element when carbon was used, but when platinum was substituted for carbon there was an immediate and copious emission of hydrogen at the surface of the platinum, and a large fall in the current.

It has been observed that occasionally the carbon electrode exists in a peculiar physical condition when it has to remain on circuit for, sometimes, a very considerable time before the current rises to its normal and steady state ; but this active condition may be at once arrived at by moistening the carbon with nitric acid before introducing it into the chromic acid mixture.

FIFTH REPORT OF THE COMMITTEE APPOINTED FOR THE PURPOSE OF CONSIDERING THE BEST MEANS OF COMPARING AND REDUCING MAGNETIC OBSERVATIONS.*

The Committee are able to report the establishment of regular magnetic observatories, where continuous photographic records of the magnetic elements are taken, at the United States Naval Observatory at Washington, and also at Los Angelos in California. The instruments used are of the Kew pattern, with the same time-scale, and the scale-coefficients for horizontal and vertical force instruments at Washington are very nearly those recommended by the Committee in their Third Report (1887), and which are in very near agreement with those at Vienna, St. Petersburg, and some other observatories.

The Committee report, further, that the plan proposed by them in their Third Report for the Comparison and Reduction of Magnetic Observations has been adopted at the United States Naval Observatory at Washington, which is now prepared to take part in the general scheme of co-operation proposed by the Committee. Copies of the photographic registers of the three elements for April 21st to 30th, May 1st to 31st, and for June 1st to 30th have been forwarded to the Committee from Washington, with tables of scale and temperature coefficients. There are also forwarded two prints showing the reduction of the declination for the year 1888, by means of a graphic composite curve, made by tracing over one another with a pantograph the daily curves of the month, and then drawing a curve through them to show the monthly means.

There are also forwarded from Washington a set of prints showing the comparison of the disturbances of declination and horizontal force at Washington for 99 days of 1888, and another set of prints showing the comparison of disturbances of declination on certain selected days at Washington, Los Angelos, and Toronto, all reduced to the same time-scale of 30·6 millimetres for two hours, *i.e.*, the time-scale of instruments of the Kew pattern.

Days in 1888 selected by United States Naval Observatory for comparison of magnetic disturbances of Declination and Horizontal Force.

January	7, 14, 15, 23, 24, 27.
February	10, 11, 18, 19, 20, 21.
March	7, 8, 9, 10, 15, 16, 17, 18.
April	2, 3, 4, 5, 10, 11, 12, 13, 14, 30.
May	1, 6, 7, 8, 9, 10, 11, 20, 26.
June	2, 3, 4, 5, 6, 21, 22, 23, 24.
July	1, 2, 7, 8, 16, 19, 20, 21, 22, 27, 28.
August	2, 3, 15, 16, 17, 18, 19, 30.
September	7, 8, 11, 12, 13, 14, 15, 19, 25, 26, 27.
October	5, 11, 19, 20, 30, 31.
November	3, 4, 6, 16, 17, 18.
December	5, 7, 13, 14, 23, 24.

The Committee are more than ever of the opinion expressed in their Third Report, "that the establishment of regular magnetic observatories at the Cape of Good Hope and in South America would materially contribute to our knowledge of terrestrial magnetism."

The Committee consider that it would be desirable to publish annually in a collected form for certain selected days the curves of the three magnetic elements, *i.e.*, declination, horizontal force, and vertical force, taken at the different English and Colonial magnetic observatories, choosing for selection in 1888 the days for which the curves are published in the "Greenwich Observations."

* British Association, Section A, Newcastle-on-Tyne, September, 1889. The Committee consisted of Prof. W. Grylls Adams (Secretary), Mr. W. Lant Carpenter, Mr. C. H. Carpmael, Mr. W. H. M. Christie (Astronomer Royal), Prof. G. Chrystal, Capt. Creak, Prof. G. H. Darwin, Mr. William Ellis, Sir J. H. Lefroy, Prof. S. J. Perry, Prof. Schuster, Prof. Sir W. Thomson, and Mr. G. M. Whipple.

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THE CHOICE OF CABLES FOR ALTERNATING CURRENTS.*

BY CH. JACQUIN.

Electricians have long discussed, and are still discussing, the description of cable to be used for alternating currents. When alternating currents were utilised for the first time, *i. e.*, for supplying the Jablochkoff candles, ordinary cables were employed. Since then, owing to the introduction of the transformer system, the use of alternating currents has largely increased, and numerous mains for alternate-current distribution have been laid. Some theorists then expressed the opinion that instead of employing two separate conductors, one going out and the other returning, it would be far preferable to have a single concentric cable, the central core forming one of the conductors, and the other consisting of a ring insulated from the core. In such a cable the two conductors are at each moment traversed by opposite currents, and consequently give rise to no field of force outside the conductors. Thus these cables produce no induction troubles on telephone lines. Moreover, the metallic sheathing is not the seat of any parasitic current. A simple cable, on the contrary, produces a variable circular magnetic field, and if it is covered with a metallic sheathing, we have a loss of energy due to the Foucault currents and other induction phenomena in this sheathing. Many, believing these losses to be excessive, have thought that armoured cables should for this reason be concentric. If it is true that concentric cables save us from induction, they offer in other respects serious inconveniences. The central stations at Berlin and elsewhere soon found this out. Defective insulation between the core and the annular ring gave rise to serious accidents. The cause of these accidents is easily understood. In a concentric cable the difference of potential between the two conductors is double that which exists between the core of a simple cable and the earth The insulation between the two conductors of the concentric cable should therefore have at

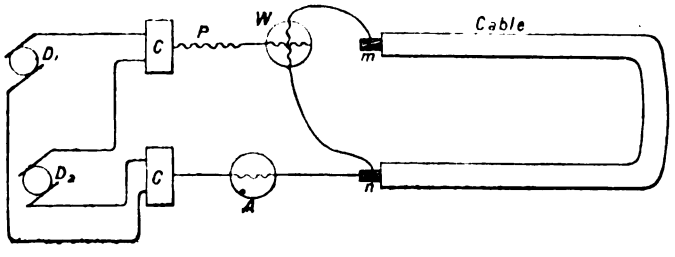

FIG. 1.

least twice the value of that of a simple cable. Now, in the first concentric cables, the insulation was far from being equal to that of the simple cables, for the makers, in the manufacture of them, had employed as a dielectric merely textile fabrics impregnated with pitchy substances. If we wish to have concentric cables sufficiently insulated, we must use very thick layers of gutta-percha, which are very difficult to vulcanise at their periphery, and then the cables become very expensive. Thus the concentric cables for the Municipal Central Station at the Halles Centrales cost 33fr. per metre, whereas the corresponding simple cable costs 8·35fr. Thus the cost per metre (lead and return) amounts in the case of the concentric cable to 33fr., against 16·7fr. for the ordinary cable. In other words, it costs twice as much. In the face of these figures it may be asked whether it would not be better to return to the simple cable. In order to answer this question it is necessary to ascertain whether the loss of energy which takes place in a simple armoured cable is really so great as to necessitate the employment of concentric cables. The question being too complex to allow of any figures being fixed *à priori*, it was found necessary to solve it by direct experiment. It was for this purpose that I carried out the following experiments. It is not surprising that no experiments of the kind had previously been made; as a considerable amount of expensive material and apparatus is required, all of which M. Henri Menier placed at my disposal in his works at Grenelle.

The plan of my dispositions is shown in Fig 1. A cable of 200 metres, unwound upon the ground, may be traversed either by the alternating currents from the dynamo D_1, or by the continuous currents from the dynamo D_2, by means of the commutator C. In the circuit are placed a rheostat, P, an electro-dynamometer, A, and the fixed bobbin of a wattmeter, W. The movable bobbin of this latter is connected with the terminals *m*, *n* of the conductor.

An alternating current from D_1 is first sent through the cable. If the cable is armoured, hysteresis, induction currents, and Foucault currents are produced in the sheathing, having the effect of creating a counter-electromotive force in the conductor; so that in order to obtain an effective current in this conductor, it would be necessary to have at the terminals of the cable a difference of potential above that given by Ohm's law. The deviation a of the wattmeter will then give the total power P expended on the cable for an effective current given by the electro-dynamometer A. Substitute for the dynamo D_1 the continuous-current dynamo D_2, and bring the electro-dynamometer to the same deflection, a smaller deflection, a', is read. The current being continuous, there is no induction in the sheathing; the wattmeter then measures simply the power $C^2 R$ expended in the conductor. The power p dissipated in the sheathing is determined by the two experiments

$$p = P - C^2 R.$$

But what is especially interesting is not the absolute value of the power dissipated, but the ratio

$$\frac{p}{C^2 R} = \frac{a}{a'} - 1,$$

which depends only on the ratio of the deflections of the wattmeter.

These are the results obtained with an alternating current of 3,000 periods per minute. If we pass an alternating current through a cable without a sheathing, wound upon the iron bobbin which serves to transport it, the power dissipated in this bobbin is equal to ten times the power expended in the conductor. This shows of what importance the parasitic currents are when the mass of iron is not divided. Once unwound, the cable without sheathing expends no more energy with an alternating current than with a continuous current. In a lead-covered cable the loss in the lead envelope, even when the two extremities are connected (Fig. 2), is only 1 or 2 per cent of $C^2 R$, as no hysteresis is produced and the magnetic field is feeble. We then worked with a cable covered with lead, then with hemp, then with iron wire, and lastly, with a material impregnated with pitch. When the cable is laid in trenches, the tarred material does not insulate, so that the iron is to earth throughout its length; this is why, after having left the sheathing insulated upon the earth by the tarred cloth, I connected the two extremities of the

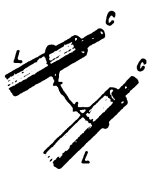

Fig. 2.

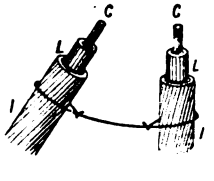

Fig 3.

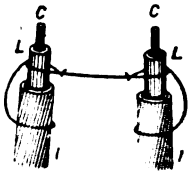

Fig 4

C = Copper. L = Lead. I = Iron.

iron by a wire of slight resistance (Fig. 3). As the lead is only separated from the iron by very weak insulation, they may also be connected. In order to make the conditions as unfavourable as possible, I connected the lead and iron by a copper wire, and then the two sheathings together as shown in Fig. 4. The following are the figures:—

Insulated sheathing

$$\frac{p}{C^2 R} = \cdot 18.$$

Extremities of the iron connected

$$\frac{p}{C^2 R} = \cdot 28.$$

Lead and iron in parallel, sheathings connected,

$$\frac{p}{C^2 R} = \cdot 35.$$

When the sheathing is insulated, only hysteresis and Foucault currents are produced, and the ratio is but ·18. When, on the contrary, the sheathing forms a closed circuit, it constitutes the secondary circuit of a transformer; a current is developed in it which is all the more intense, since the resistance of this circuit is feeble: thus, with the sheathings connected, the ratio is from ·28 to ·35. It may be remarked that the last case is not frequent in practice, for the resistance between the iron and the lead can never be altogether disregarded. Thus, ·35 is a maximum.

These figures relate to a current of 3,000 periods per minute. With currents of 6,000 to 7,000 periods per minute, the loss in the covering would evidently be greater. We may say that the loss in the envelope of a lead-covered cable is from 2 to 3 per cent.; while in a cable covered with lead and iron, the loss in the covering reaches the high maximum of 45 to 50 per cent. of the power dissipated in the conductor itself. Now it must be remarked that alternate-current cables are almost always traversed by

* From *l'Electricien*.

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currents of high tension, and that the loss in the conductor never reaches more than 5 per cent. of the total power produced by the machines. Considered from this point of view, the additional loss due to an envelope of lead may be entirely disregarded. In a lead and iron cable the loss due to the covering is at its maximum 2·5 per cent. of the total power of the station.

It follows from these experiments that it is always more advantageous to employ simple cables, even when armoured, than concentric cables, and that there is no need to fear a detrimental effect upon the neighbouring telephone lines. In fact, the loss due to this cause is comparatively slight, and the mains cost half as much. The advantage becomes incontestable when we only employ a covering of lead, since a simple cable of this nature does not expend appreciably any more power than a concentric cable. In practice, we can in many cases content ourselves with a tube of lead, and substitute for the iron armour another mechanical protection, such as an earthenware tube or a tube of impregnated wood.

THE ENERGY-RELATIONS OF GAS AND ELECTRIC LIGHTING.*

BY DR. HENRY MORTON.

During the past ten years most of the brightest minds among inventors have been occupied with the problem of the production of light from electricity, and immense progress has been made in the way of improvement in this department, but relatively little attention given to the development of light by direct combustion. In both the best incandescent lamp and the best gas-burner the losses are enormous, and the possibilities of improvement immense.

Consider, first, the "mechanical equivalent" of light. In 1865 Prof. Julius Thomsen, of Copenhagen, showed that it was about 12·28 foot-pounds per minute, or 749 foot-pounds per hour, for each candle. Mr. M. G. Farmer, however, proved years ago, as the result of certain experiments made at Boston with an electric light, that it was about 10·1 foot-pounds per candle per minute. This would give an average of 11·29 —say 12—foot-pounds per candle per minute. If 1 candle-power per minute represents 12 foot-pounds, 1 candle-power for an hour would be equal to 720 foot-pounds in the same time. This being the "mechanical equivalent" of light, however produced, the question is to find out what proportion of the total "mechanical equivalent" latent in a cubic foot of ordinary illuminating gas is converted into light by burning in a standard gas-burner. Taking the Hoboken gas for the purpose of my investigation, I ascertained that it gave 640 heat-units per cubic foot. This, multiplied by Joule's equivalent of 772, gives 493,080, or in round numbers 500,000 foot-pounds. Burning in a Sugg standard burner so as to give the light of 16 candles, Hoboken gas would be consumed at the rate of 4 cubic feet per hour. This gives an efficiency of 4 candles per cubic foot. Each cubic foot will, therefore, give 4 candle-power for an hour. Consequently each cubic foot so burned would, in an hour, give out light equal to 2,880 foot-pounds; and this is the total energy of the light developed. While it is giving out the 2,880 foot-pounds of light energy, it is at the same time giving out the 500,000 foot-pounds as the total energy of combustion. The percentage of light energy to total energy is thus 0·6 per cent. This shows that the Sugg burner turns the available total energy into light energy by a method which is very wasteful. The Welsbach burner was then tried, and its efficiency was found to be 1·4 per cent.

In the case of the incandescent electric light, the following figures were found. Assume that practically we can get 10 lamps of 16 candles each for each horse-power expended. This figure will make, for each horse-power, 160 candles. Now, at 12 foot-pounds of energy per candle per minute in the form of light, this would give us 1,920 foot-pounds of energy per minute, in the form of light, from these incandescent lamps. A horse-power expresses 33,000 foot-pounds per minute. Comparing these numbers, we get 5·812 per cent. of the total energy developed as light, instead of ·6 per cent. in the case of the gas-burner. In other words, in the electric lamp we have about ten times as much of the total energy usefully converted into light as in the ordinary gas-burner.

Going back to the coal as the source of energy, however, we are at once confronted with this other condition: In the steam-engines used for running electric light plants (and this is not the result of mere guess, but of a number of measurements which have been made at the Stevens Institute, by various members of its faculty, on electric light plants), we utilise only about 5 per cent. of the energy of the coal used to produce the power applied to develop the electric current. On the other hand, in gas making I think it is fair to say that there is not any greater waste in the production of gas from coal than 50 per cent.; and therefore you get into the gas 50 per cent. of the energy of the coal. From this you will see that there is here the same ratio (1 to 10) between the gas and the electricity, only it is turned the other way. In order to turn the coal energy into motion (as in using the steam-engine to drive an electric light plant), we throw away 95 per cent., and only ulilise 5 per cent.; in order to turn coal into gas we throw away 50 per cent. and utilise the other 50 per cent. So that, getting 5 per cent. in one case and 50 in the other, the proportion is as 1 : 10. This brings the two systems to an equality again; for, starting with the coal, about as much of the total energy of the fuel is developed by the ordinary gas-burner as by the electric lamp. Thus, starting with the coal pile, and considering merely the question of the conversion of coal into light, one process is about as wasteful as the other at present.

* Abstracted from the *Stevens Indicator*.

THE BATH ELECTRIC LIGHT STATION.

The station building, now nearly completed, consists of two parallel rooms. The engine and dynamo room is 150ft. long by 40ft. wide, the boiler room is 100ft. long by 40ft. wide. Besides these rooms there are separate offices and test rooms, whilst over the front portion of the building there are three upper floors for stores and workshops. The premises have an unique situation for the supply of coal and other stores. The frontage is on a good main road, the river Avon runs at the back, on one side is the Great Western Railway station, on the other is the wharf of Messrs. Gerrish and Co., canal carriers.

The first instalment of plant now being erected consists of the following:—Two Babcock and Wilcox boilers of 150 horse-power each, working at a pressure of 140lb. per square inch. These supply steam for two of the Brush Electrical Engineering Company's compound engines, each of 150 indicated horse-power, and also four of that company's compound engines of 30 horse-power each. These engines are supplied with variable (hand) expansion gear. The exhaust steam is carried to a surface condenser, which is worked by independent pumps. The water is fed to the boilers by means of a donkey pump, but, as a reserve, an injector is placed on each boiler. The two large engines drive two Mordey alternators of 75,000 watts each. The four small engines drive four Thomson-Houston 50 arc-light dynamos, supplied by the firm of Messrs. Laing, Wharton and Down.

The mains for the district which will be supplied with electricity at once will require 40 miles of wire. These mains are being laid underground by Messrs. Callender and Co. The whole of the district, comprising 50 streets, squares and crescents, which is to be supplied, will be lighted by Thomson-Houston arc lamps from the 25th of March next, Mr. Massingham's contract with the local authority being for a term of seven years from that date. The arc lamps will be suspended over the streets from brackets placed on iron columns 30ft. high, the arc being 24ft. from the ground, this distance having been found the most effective at Taunton.

The size of the station provides for 2,000 horse-power in use, with ample spare power, and there is every reason to believe that all this power will be wanted within a few years.

LONDON CHAMBER OF COMMERCE.

Meeting of the Electrical Trades Section.

A meeting of the Electrical Trades Section was held on the 28th inst., Major S. Flood-Page, Vice-Chairman, presiding.

The following reportwas read:—

THIRD REPORT OF THE CORRESPONDENT.

Overhead Wires.—Three meetings of the Committee were held, and Major Cardew was consulted on several occasions by the Correspondent and by other members of the Committee about the interpretation and modification of the rules. A letter was written to Mr. Courtenay Boyle asking for certain minor changes. The alterations effected by the action of the Chamber were in the definition of "low pressure," which was altered from 300 volts to 600 volts if the system be earthed in the middle, and in the definition of the materials to be used for insulation, the word "india-rubber" being omitted. It is believed that the Board of Trade are instituting tests of silicium and other bronze wires, with the view of granting further concessions, if possible, for wires taking their own weight, without bearers, but at a full meeting of the Council of the Institution of Electrical Engineers, on the 25th inst., it was decided that they were not at present prepared to recommend any alteration of Rule 12.

British Association Screw Thread.—186 circulars were sent out, and only twenty replies were received. These came to hand just

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before the meeting of the British Association at Newcastle, and as the Association exists practically for only one week in each year, except for purposes connected with its own organisation, a letter was written to the Secretary of the Mechanical Section, giving an analysis of the replies, in the hope that the Association might take some steps to popularise the matter. It appears, however, that as the Screw Thread Committee has been dissolved and the Committee of the Section is merely constituted to arrange the Papers to be read at the meetings, no notice was taken of the communication.

When the Post Office decided to adopt the British Association thread in the construction of its instruments, Mr. Th. Lehmann, of 28, Hampshire-street, Torriano-avenue, N.W., was appointed to manufacture the taps, screw-plates, and dies, and to supply them to the Post Office. Of Mr. Lehmann, whose name is not familiar in engineering circles, it is sufficient to say that he was formerly manager to Mr. Stroh, and superintended the construction of the most accurate work on the instruments for the Telegraph Department of the Post Office. At the invitation of the Correspondent, a box containing a set of tools is exhibited by Mr. Lehmann. Mr. Preece has kindly lent a sample set of tools, and a case containing a sample of every kind of screw used by the Post Office. Messrs. Davis and Timmins also exhibit samples of screws.

Standardising Laboratory.—At the request of the Board of Trade, 212 circulars were sent out, and thirteen replies containing returns, together with six blank forms with letter explaining reasons for not replying, were received. The totals were as follows: House-meters, 1890, 6,160; 1891, 13,100. Ammeters, 1890, 400; 1891, 581. Voltmeters, 1890, 556; 1891, 891. A letter containing these totals was forwarded to the Board of Trade, calling attention to the fact that only two supply companies had been able to estimate their requirements. With regard to the establishment of a laboratory, it is believed that Her Majesty's Treasury continues to give the matter its most careful consideration.

Messrs. Davis and Timmins informed the meeting that the replies to the circulars gave a very erroneous idea of the extent to which the British Association screws are being used, and added that the circular had stirred the matter up, and had produced further inquiries.

Mr. Trotter said that the circular on the Standardising Laboratory had been greatly misunderstood by instrument makers, who did not seem to be aware that all instruments used in connection with the sale or supply of electricity would have to be certified, or their indications could not be taken as evidence in case of dispute. One of the replies stated, "We have at great expense fitted up at our works one of the most perfect standardising laboratories in England: we should have no use for the one you refer to." Another says: "There are a considerable number of instruments sold by us, and at prices above what similar instruments can be bought at, because of the reputation of our testing staff and appliances, and the recognised accuracy of the results. If this laboratory is established, it will certainly benefit newer firms who have not the same reputation; but we fail to see that we should be likely to get an enhanced price—indeed, the opposite would probably be the result."

In the absence of Mr. Crompton and Lord Crawford, the question of the Metropolitan Building Act was not discussed, but it was explained that the Metropolitan Building Act, formerly administered by the Metropolitan Board of Works, allowed a certain amount of discretion to their surveyors, by which they could have dispensing powers for certain items. The County Council now prohibited all such dispensing power, and all departure whatever from the letter of the Metropolitan Building Act had to be referred to the County Council itself.

Mr. Murray (Secretary of the Chamber) reported with regard to the commercial education scheme, and scholarships, and prizes.—Mr. Price thought it would be a good thing if young lads were brought up a step further than the ordinary run of education if they intended to go in for electrical work. He thought scholarships and prizes given for electrical work would be most desirable.—The Chairman said they generally approved the action of the Council in the matter.

In connection with railway rates, Mr. Murray reported that the case for the Electrical trades would not come on at the Board of Trade inquiry for some months, and in reply to a question, stated that most of the objections raised by the Section were identical with those of other Sections, and would be taken altogether.

Major Flood-Page (the Chairman) said he had a matter of very great importance to bring forward. It had been determined to have in Edinburgh what was called an International Exhibition of Electrical Engineering, General Inventions, and Industries, to be held next year. Some of the rules which had been drawn up were very stringent. He thought that the time had come when everybody connected with the electrical industry should speak out. They would agree that exhibitions, especially when 400 miles away, were very expensive. They got very little out of them, and it was neither fair nor reasonable that gentlemen in Edinburgh who wanted to make money for the people there should call upon others to bear the expense which was necessary for such an exhibition. If the electrical profession responded, the amount that they would have to expend would be measured by tens of thousands of pounds. It was within his own knowledge that one firm had spent about £6,000 in connection with one exhibition, and yet they were not able to trace a single order from it. He would therefore suggest, not that they should not exhibit, but that they should exhibit on their own terms, and not on the terms of the exhibition authorities. He would like to point out that an electrical exhibition could not be successful without the help of the Electrical Trades Section; in fact it could not be undertaken if they chose to stand out, for they embraced almost the entire electrical world. However, they were now called upon to pay for space, delivery, arranging, cost of installation, and insurance. It was time that they should arrange to have free rent, free power, and free current. If they asked for that which was fair and reasonable, and if they were united, they would be taken on their own terms or there would not be a successful electrical exhibition. He then moved the following resolution:

"*That with a view of the electrical industry taking common and united action with regard to the proposed Electrical Exhibition in Edinburgh in* 1890, *a committee be appointed to consider the conditions on which it may be advisable to take part in the exhibition, and that a meeting of the Electrical Section of the Chamber be called for Monday,* 14*th November, to receive the report, and if thought advisable to take action thereupon.*"

Mr. Swinburne seconded the motion, which was carried, and the committee was then formed.

OCEAN CABLE REPAIRS.

The following article from the New York *World* may prove of interest to some of our readers who are not acquainted with the work of cable repairs:—

The idea of the broken ends of these cables, lying hundreds of fathoms deep beneath the track of passing vessels, and hundreds of miles away from land on either side, appeals in a peculiar way to the ordinary imagination; and it appeals to the imagination of anyone who knows fairly well what the bottom of the ocean is like more strongly still than it does to a person who has a prevailing notion that the bottom of the ocean is all sand and extends pretty much like a billiard table from one continent to the other. But fancy for a moment a cable strung across the mountains of this continent and dropping into the valleys by sheer force of its own weight; falling from the pinnacle of Mount Washington and trailing across the Hudson River, climbing the Alleghanies and the mountains of Tennessee and dropping thence into the valley of the Mississippi, winding across the plains and climbing the Rocky Mountains on the way to San Francisco, and then flood this immense area with a mighty ocean, and a practically faithful picture of a deep-sea cable is presented. Starting from land on the other side, these Gould cables descend into the valleys, reach up to the tops of the hills, turn and twist and go around and climb across; and fathoms and fathoms above them the waves break themselves against each other, and storms lash the waters into fury, or the sunshine spreads them out serene and placid as a mirror. And it is the picture of these broken cables, broken half-way down a hill, or buried in the sands half-way across the valley, that captivates the fancy and makes one wonder over the science of man, which enables him to pick up those ends from the mysterious depths of ocean and put them together again. The location of a cable break can be very accurately determined by electricians. After having found out how far from land the break is, the only other thing the captain or navigator of the cable steamer wants to know is in what direction that distance is to be travelled; and as the course of the cable is perfectly well known from the fact that when the cable was laid accurate observations were taken by the cable layers and records made, the cable steamer starting out to do the repairs can steam directly over the spot where the break is located. Of course, when this statement is made, it is not at all meant that the location can be determined within a few inches or a few feet, but it can be determined within a very limited area, so that the grappling for the ends of the cable does not usually extend in good weather over a period greater than two or three days, and sometimes does not last even so long as that. The grappling-irons are immense affairs, attached themselves to cables manipulated from the deck of the steamer, and are plunged downward and dragged over the bottom of the ocean. When the cable is finally grappled the fact is made clear at the steamer end of the line by reason of the strain to which the grappling-iron is subjected. The strain is revealed by an instrument on board the steamer known as a dynamometer. When this instrument reveals the presence of such a strain as the grappling of the cable would bring about, the iron is hauled up with the cable at the end of it. The repairers always calculate to grapple the cable about ten miles away from the point at which the break has occurred. If the irons grappled the cable too near the end, the cable would slip away long before it reached the deck of the steamer. In some instances no break has occurred at all, and electrical communication has been interrupted perhaps by the destruction of the insulated covering of the cable, or by some defect of a similar character, so that when the grappling-iron appears at the surface of the water, the entire length of cable comes

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up with it. The break is then spliced, or the defects remedied, and the rehabilitated cable is consigned once more to the bosom of the mighty deep. Of course, many times it is not possible to determine exactly what the cause of a cable break has been, but usually the trouble is that the cable has been laid too taut, and it has broken or been damaged in a serious way by reason of the immense strain resulting on this excessive tautness. The consequence is, that whenever a repair is made in mid-ocean the repairers cut away all the twisted and strained cable in the immediate neighbourhood of the break, and do away with all possibility of tautness by putting in 25 to 50 miles of new cable. This may meander down the side of a submerged Mount Washington, or may curl quietly up in the basin of a Mohawk Valley, but, whatever it does, there is no chance of the cable breaking in that particular spot again from being drawn too tight. Outside of this, cables are frequently damaged by the anchors of vessels, fishing vessels chiefly, which anchor for the purpose of carrying on their fishing. Accidents of this kind occur, of course, near the shore or the banks of Newfoundland. The anchor becames entangled with the cable, and, rather than spend the time necessary to get it free, the cable is dragged up and cut, and the vessel proceeds on its way. Simply to avoid a little trouble the captain of a fishing vessel will put a cable company in for thousands of dollars of expense. The situation is recognised by the cable companies, and they have a standing offer to indemnify any vessel for the loss of an anchor, and they pay out large sums of money every year on this score. It will be seen that there is no possibility of verifying such claims, and the consequence is that false claims for damages have undoubtedly been put in and unscrupulous captains have collected money for anchors which were never lost. Another source of trouble to the cables are the icebergs. These icebergs, floating down from the arctic seas, frequently extend beneath the surface of the ocean for many hundreds of fathoms, and the base of the passing iceberg catching the cable bears it onward and finally snaps it in two. The bottom of the ocean varies in depth in a very marvellous way, right in the path these icebergs usually take. Off the banks of Newfoundland the bottom is reached sometimes at so inconsiderable a depth as 75 to 100 fathoms. But from the point where the depth is 100 fathoms the ocean bottom goes down the side of a mountain to 2,500 fathoms, or two miles and a-half, within a very short distance. Perhaps the bottom rises up again and the cable hangs between the two submerged mountain tops, and the iceberg coming along quietly picks up the loop thus formed and carries it onward until the strain results in an absolute rupture. There are stories of cables having been injured by whales and other monsters of the deep, but these interesting tales are to be taken with a good deal of allowance. One tale is to the effect, and it is a tale in more senses than one, that when a faulty cable was once dragged on deck the decomposed body of a whale was found within the twisted and convoluted cable, and electrical communication had been interrupted because the cable had got around the whale and the whale had got around the cable. This Munchausen story may be true, but it cannot be verified. Another fairy tale which has attained limited circulation is that a mid-ocean cable was attacked by a sword-fish, the sword-fish labouring possibly under the impression that the cable was an elongated eel, and the result of the attack was that the cable was peeled of its outer covering and the bare wires were left to the mercy of the immediate and watery surroundings. All the cable companies regard cable breaks as a part and parcel of their legitimate business. They are never surprised when a misfortune of this kind overtakes them, and, so far as financial considerations are concerned, they are always prepared for it. Indeed, all the companies put away so many thousand dollars every year to pay for anticipated breaks of this character, so that the money which goes for repairs does not come, so to speak, directly out of the treasury. It has already been appropriated for the purpose to which it is applied. The only break which the cable people really dread is the break which occurs not in mid-ocean but in mid-winter. It is quite obvious that the repairing of a deep-sea cable, when the waves are rolling mountains high, is no easy task, and under these circumstances grappling for a cable is something very difficult of accomplishment. In the summer, though, and particularly in October, after the equinoctial storms, when the skies are serene and the surface of the ocean frequently as placid as the surface of an inland lake, the matter of repairing the breaking of a cable, unless, indeed, it interferes seriously with business, is not regarded in so serious a light.

The cable buoy is used in repairing cables if the break happens in winter time and a storm comes up and begins to hustle the steamer around in such a way that it isn't possible to keep the end of the restive cable on board. At such a time as this the cable is attached to the cable buoy and the buoy is thrown overboard. When the weather subsides the cable is easily recovered, and the splicing is done. Of course, as soon as the cable is found, communication is established between the steamer and the cable station on one or the other side of the Atlantic. If the communication between the steamer and Ireland is all right, for example, it is known that the cable is uninjured between those two points, and when this has been determined the repairing goes on until the American side of the ocean and the steamer are brought into electrical contact. It may be mentioned that in grappling for a cable with the grappling-iron, the steamer proceeds in a course exactly at right angles to the cable, so that the cable is usually caught within a comparatively short time."

Of course the cost of repairing a cable is very considerable. When it is considered that a fully-equipped ocean steamer, with an expert navigator and expert electricians on board, is devoted exclusively to the business of repairing the cable for a length of time extending anywhere from two weeks to a month, some idea of the cost may be arrived at. The Commercial Cable people have their own steamer, which represents an investment of several hundred thousand dollars, and the officers and electricians are on the pay roll of the company from one year's end to the other. The Anglo-American Compary, which owns four cables in the pool, also has a cable steamer, called the "Minia." The Western Union people have no steamer of their own, and when they need a steamer hire either the "Minia" from their associates in the pool, or the "Faraday," which is owned by the Siemens Brothers, of England, who maintain the "Faraday" because they are cable manufacturers, and use the steamer as a general thing for laying new cables. When the "Minia" is hired out its owners charge $800 a day for it, and when the Siemens Brothers have the "Faraday" at liberty their daily rental is $1,200. As three weeks is perhaps an average time required for the proper repair of an ordinary cable break, it will be seen that the mere rent of the steamer amounts to about $25,000. To this is to be added, of course, the actual cost of the repairs and the 25 or 50 miles of new cable. And cable, if it were sold by the yard, would be sold almost at the price of fine lace. The two cables which the Western Union intends laying from Nova Scotia down into New York Bay, a distance of 840 miles, will cost, with the laying, about $1,600,000, and presumably the cost of laying bears the same relation to the cost of the cable as the cost of carpet-laying does to the price paid for the carpet. Some cable breaks have probably cost $100,000, but it will be seen that the cost is entirely dependent on conditions which cannot be foreseen and cannot be controlled. A foggy day with the "Faraday" in commission means an absolute expenditure of $1,200, and a week of foggy days will bring this up nearly to $10,000, both from the fact that observations cannot be taken in bad weather, and from the fact also that successful grappling cannot be conducted when the surface of the ocean is disturbed unduly by storms; clear, bright weather is almost absolutely essential to the prosecution of repairs.

The finding and repairing of the original Field cable is probably the most remarkable triumph in the whole annals of the science of navigation. When that first Field cable was laid nobody knew as much about cable-laying as they have since found out, and no particular or especial pains were taken to record the exact course of the steamer and consequently the location of the cable. It parted in mid-ocean, and for five years no attempt was ever made to do anything with it. At the end of that time, and after a second and more successful cable had been laid, the "Faraday" steamed out on the trackless ocean to pick that cable up, did pick it up, spliced it, and finished successfully the job of laying it. Here certainly the difficulties in the way seemed overwhelming. The only thing the searchers had to guide them in their search was the log of the steamship "Great Eastern," which made known the course of the vessel certainly, but not with the extreme accuracy which was in such a case every way desirable. More than that, the cable had lain at the bottom of the ocean for five years, and probably the grappling-irons passed over it a number of times before they finally grappled it. When it was got hold of it was incrusted with all manner of ocean growths, and Cyrus W. Field is said to have a piece of it about a yard long covered with coral. When this successful achievement is considered, the work of finding and repairing a cable, where the break is known to be a certain number of miles from the land and the original course of the cable is a matter of accurate knowledge, dwindles into comparative insignificance.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 19, 1889.

Since my last letter to you the city of New York has been in a state of turmoil, agitation, discussion and indignation over the question of putting the electric light wires underground. The whole matter originated with the killing of a Western Union lineman on a pole quite close to the City Hall and the Courts, just about middle day, when the streets were fullest of passers-by. This lineman appears to have gone at his work in the ordinary way without taking any precautions to ascertain whether the wires were clear of current or not, and, it is said, not only with bare hands but with bare arms. Be this as it may, he had not been on the pole very long before he was seen to have succumbed to a shock, and some delay occurred before his smoking body, around which an arc played, could be removed. If this had occurred in the outskirts of the city probably little more than usual would have been heard about it, but as it was within a stone's throw of all the newspaper offices, the reporters immediately swarmed thither, and the consequence was that that night and the next morning New Yorkers were regaled with one of the most sensational dishes of horrors that can well be imagined. Thereupon sprang up a great and unreasoning popular clamour, which reacted at once on the somewhat lazy Subway Board, and which encouraged the Mayor to pose once again in the attitude of a popular reformer, determined to protect the people's welfare, at whatever cost. He immediately wanted every one of the circuits stopped and chopped down, and probably would have had his way by this time had not the Courts interfered to protect the property of the companies. Not only has the Subway Board been stimulated to activity in the matter, but other authorities have felt that they were called upon to interfere. The Park Commissioners, as they do not

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expect to return to the use of the electric lights until the wires are buried, have requested the Department of Public Works to put gas lamps in the small squares and parks down town, and the Board of Health has gone so far as to pass resolutions recommending that continuous currents above 700 volts and alternating currents above 250 volts shall be forbidden. In the meantime a great many more of the poles have been chopped down, but, under the protection of the injunction of the Court, the companies whose circuits were in bad order have been putting up new wires. It looks as though the outcome of the whole agitation would be not a resort to lower potentials, but a more general resort to the conduits, and, in view of this probability, a great deal of interest is felt in the control of the subways. The Consolidated Telegraph and Subway Company, which has done all the subway work thus far of a general character, under the authority of the Subway Board, has, according to Mayor Grant's view, not been expeditious enough in its work, and he has sought to annul its franchises for that reason. There can be no doubt, of course, that a great many of the arc light wires in this city have been in bad condition, but there are many excuses to be offered for the companies in spite of their faults, and one of these excuses is that they have not been allowed to keep up their circuits as they desired, even where there were no subways to go into, and that where there were subways to go into it was hardly likely that they would rush into them when they had to pay $800 a mile. As I have said, however, we shall now probably see a rapid extension of subway work, and a great many of the electric light wires, arc and alternating, placed in them. This will probably satisfy the public, and perhaps silence some of the newspapers which have been talking so foolishly on the subject, but I am afraid it will not very greatly improve the conditions for the linemen, who certainly should be safer on poles than they would be in narrow little manholes, where the connection to ground through the damp earth and brickwork is about as complete as one could well make it. Of course, the reporters have been flocking in large numbers to Mr. Edison to ascertain his opinion on the subject, and he has naturally once more reiterated his well-known views in favour of low tension; but it is to be borne in mind, as has been pointed out, that the Edison parent company not only employs the Edison municipal system at 1,200 volts, but has lately been recommending its sub-companies to go in for arc lighting on the series system, so as to withstand the pressure of competition.

Another interesting piece of news of the week is the acquisition of the control of the Brush Electric Company of Cleveland by the Thomson-Houston Company of Boston. This is another of the great consolidations that have been on the tapis for some time past. Although little is as yet known as to the terms of the arrangement, it is said that the consideration is at the rate of $3,250,000 for the whole property. It has been understood for some time past that Mr. George Westinghouse has himself been seeking to acquire this valuable and desirable piece of property, and when recently he bought out the local Brush Company in this city, it was supposed that the first step in the matter had actually been taken. It now appears, however, that the Thomson-Houston Company have got the better of him, although perhaps it may be that Mr. Westinghouse did not care to go quite so high in the matter of price, and considered that he could get along better without the purchase. This last move leaves but three large companies for electric lighting manufacture in the field, and it may reasonably be supposed that matters will end there, there being apparently no love lost between either the Thomson-Houston, Westinghouse or Edison interests. It is possible, therefore, that the triangular duel *a la* Midshipman Easy may be fought out for some time with a great deal of bitterness, and then——

One of the financial papers of this city states that the Electrical Accumulator Company, in a circular signed by Mr. Theo. N. Vail, its president, has proposed to its stockholders a plan of reorganisation which shall take over the property and business of the old company, and some $300,000 is required to carry on the business and liquidate the outstanding indebtedness. At the present time the capital stock of the old company of $5,000,000 is stated to be wholly issued and fully paid, while of another issue of $1,000,000, $617,400 have been sold and $235,000 have been hypothecated. There seems little reason to doubt that, although the company has spent a large amount of money in its work, it will effect its reorganisation and carry on the business, which, in spite of many drawbacks, seems destined to develop and grow steadily, if not rapidly.

There is great and continued activity in the development of electric railroading, and the Convention this week at Minneapolis of the street-railway men will doubtless bring out many interesting and encouraging facts with regard to this new application. The electric railroading schemes are actually getting colossal, as an instance of which I may mention the long-distance road it is now proposed to put in between Seattle and Tacoma, in Washington. This road will run a distance of not less than 30 miles, the power being furnished by four stations along the road. It is understood that large local bankers are interested in the project, and there seems reason to believe that the scheme will be carried out. With regard to the general development in this field, it is interesting to note that a table, published by the *Electrical World* this week, shows that there are no fewer than 179 roads, or extensions of roads, built or under contract in this country, with an aggregate of 1,260 miles of track and 1,884 cars. In a great many instances the details of the table are supplemented by statements as to the cost of operation, and it would appear that the cost of power in every instance reported upon is far below that of animal locomotion. Many of the companies speak enthusiastically about the service and system, and give evidence of their faith by going in heavily for an enlargement of their line and equipment.

At a meeting of the American Institute of Electrical Engineers this week, Mr. Thos. D. Lockwood, the well-known electrician and patent expert of the American Bell Telephone Company, read a very interesting Paper, descriptive of his recent travels through England and a portion of the Continent, and of his observations on what was being done in the electrical field. Although Mr. Lockwood has been credited with the possession of genuine Transatlantic humour, he is an Englishman born and bred, and although he makes a first-class American, his English characteristics are such as to be immediately recognised by those who come in contact with him, especially if the contact happens to be stand-up fight. Mr. Lockwood may, therefore, be taken to be a fair and impartial critic, and I think English electricians will be glad that he recognises the solid progress that has been made among them, even although it has not been so rapid as our own. In fact, Mr. Lockwood has long been known as the dogged enemy of the electrical Cheap Jack, and as the persistent advocate of good and thorough work, and hence he finds a great deal in England that is worthy of admiration, as compared with what can be shown here in the matter of hasty, scrambling construction. It is interesting to observe, however, that while appreciating the good points of the Government telegraph system in England, Mr. Lockwood is not in favour of a Government monopoly of the telegraph in this country, and that he is equally averse to any control by the official authorities of the telephone system. Mr. Lockwood was impressed, as most Americans are, with the absence of electric lighting on a large scale, but, as a telephone man, he was a little bit inclined, perhaps, to look upon this as a blessing in disguise. In the discussion that followed on Mr. Lockwood's Paper, Mr. G. L. Addenbrooke, of London, participated. That gentleman is now on his way home from Australia, where he has been engaged in electrical work. and he greatly interested his auditors by describing the methods of line construction in England, and especially those employed for the distribution of the Ferranti alternating currents at 2,500 volts from the Grosvenor Gallery plant.

The subject of electricity continues to occupy the attention of the non-technical Press in a remarkable manner, and we even find the papers and magazines for children publishing elementary disquisitions on this absorbing theme. *Scribner* accompanies next month its interesting series of articles on electricity by two Papers on electricity in war. One, on naval warfare, is by Lieutenant W. S. Hughes, of the U.S.N., and the other, on land warfare, is by Lieutenant John Millis, of the

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Engineering Corps. These two Papers will be copiously illustrated, and will show how much electricity has done in the way of perfecting the processes and appliances to the "abominable end of annihilating mankind." While these Papers do not embrace much that would be novel to your readers, they put together compactly all that has been done up to date. Lieutenant Hughes mentions the fact that the incandescent plant on the "Trenton" was, so far as is known, the first of its kind in the navies of the world, and he also points out that it has been left to the United States to take the initial steps towards the introduction of electric motors on men-of-war by placing them on board the new steel cruiser "Chicago," where, if I am not mistaken, they not only work one of the 18-inch guns, but run a shot-whip or hoist. Lieutenant Millis, whose Paper in some respects will overlap that of Lieutenant Hughes, devotes an interesting section to the subject of torpedoes, illustrating his remarks by views of the Sims-Edison electric torpedo, as started from the shore, and making its way around or under obstacles intervening in its path. Yet another article of general interest is that which has just appeared in *Harper's Weekly* on the subject of electricity as applied to street-car propulsion. This article is written by Mr. H. L. Nelson, and goes over the whole ground of what has been done in recent years. Mr. Nelson presents the point very clearly that operating by electricity is economical for street railways, and that one of the noticeable features has been the wonderful increase in traffic along the electric lines, as well as the advance in the price of real estate.

Speaking of electric railways reminds me that on one of the new roads that has recently gone into operation at Cincinnati, the word "motorneer" has been definitely adopted for the drivers of the cars. Each of the men in charge of a motor-car, or a locomotor, has a band around his hat with the word "motorneer" on it. This new coinage is not a very elegant one, nor is it very generally liked, but it seems to be adopted out of sheer force of necessity, and partly, perhaps, because it has some sort of rough phonetic analogy to "engineer." This road is also somewhat of an original one in its method of operation. It runs from the very heart of Cincinnati, where its overhead wires are carried past some of the finest buildings without in any way disfiguring them, to the foot of an incline. Then the cars are hoisted on elevators to the top of the bluffs that dominate the city, and thence they run by electricity through the suburbs out to the well-known Zoological Gardens. The president of this road, it is worthy of mention, is Mr. H. H. Litell, an old and well-known street railway man, to whom belongs the credit, I believe, of founding the American Street Railway Association. The fact that such a man is actively and enthusiastically interested in street railways tells its own story.

BRUSSELS NOTES.

(FROM OUR CORRESPONDENT.)

BRUSSELS, *October* 22, 1889.

Belgian electrical exhibitors at the Paris Exhibition have, I am glad to say, come off with their fair share of awards. Gold medals have been awarded to M. Julien Dulait, of the Société Électricité et Hydraulique, of Charleroi, to M. Joseph Jaspar, to the Société Anonyme l'Électrique, to the Société Anonyme Franco-Belge d'Appareils d'Éclairage, of which M. Bandsept is managing director, and to M. Van Rysselberghe. Silver medals were also awarded to MM. Courtois and Emile Gérard, and to the Société Anonyme Belge pour l'Éclairage et Transmission Electrique á Longue Distance, in addition to which a bronze medal and an honourable mention were obtained.

M. Van Rysselberghe's proposals for the lighting of Brussels, about which I spoke in my last letter, did not meet with much favour in the eyes of the Special Committee, who listened to further explanations from M. Van Rysselberghe a few days ago. The Burgomaster and several councillors were present at the sitting, and it was generally understood that these proposals had been rejected. M. Van Rysselberghe, however, still keeps his ideas before the public, and a second *brochure* from his pen has appeared, in which he vigorously attacks the system employed at Berlin, insisting on its costliness and the danger arising from a collection of high-pressure boilers placed in the midst of a densely-populated district. If a high tension system of electrical distribution were employed, I am inclined to think that most of his remarks would lack point.

The works of M. Julien Dulait, at Charleroi, have lately been considerably enlarged, and a carbon factory has now been added. The shops are very busy, and night-work is necessary to keep pace with orders.

October 28, 1889.

The Special Committee have decided to advise the town authorities to divide the town into two areas for electric lighting purposes, each of which will be allotted provisionally to a concessionnaire with a view to testing his system on a large scale. One of the concessionnaires is to be M. Van Rysselberghe, who will, therefore, have an opportunity of showing what his hydro-electric plan is capable of. The second area will be allotted to whichever company offers the best terms. When the provisional concession has expired it is proposed that the concessionnaire whose system is decided to be the worst shall hand over all his rights to his successful rival. It will be interesting to watch the outcome of this proposition.

A small Tudor accumulator station has just been opened at Ghent. At present the capacity is only 900 20 candle-power lamps, but a second battery, doubling the output, will shortly be erected. The charging is effected by Tudor dynamos running at 900 revolutions, and having an E.M.F. of 160 volts.

SCANDINAVIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

COPENHAGEN, *October* 28, 1889.

The Swedish State Telephones are contemplating taking another important line in hand very shortly, viz., between Uddevalla-Vennersborg and Gothenburg. This line is one of the six main telephone lines to which the last Swedish Parliament voted a grant of 750,000kr. The length of the above line is 109 kilometres, and there will be a double 2·6 millimetre copper wire. Also, in Norway, the telephones are being greatly extended. Of new lines in the course of erection may be mentioned those between Drammen and Kongsborg, and between Christiania and Moss. The latter line, which is being installed by the local telephone companies in the two respective towns, pays 2,000kr. to the State Telegraphs as compensation for possible decrease in the number of telegrams passing between the two towns.

The Electric Engineering Company (Elektriska Aktiebolaget), Stockholm, decided at a recent general meeting to enter into co-operation with a new electric company for transmission of power. This new undertaking, which has just commenced operations, has its head-quarters at Arboga, Sweden, the firm being "Wenströms and Granströms Elektriska Kraftbalaz." Oddly enough, electricity has hardly at all been used in Sweden for power, although this country offers special facilities for installations of this nature owing to its enormous quantity of water-power. The various electrical firms have, however, been too busy with light installation to give much attention to the other department, so the new firm will probably find plenty to do. An electric railway at Boxholm will be its first work.

The various workshops and other buildings belonging to the Swedish artillery at Karlsborg have recently had electric light installed. The well-known firm of Palmcrontz and Co., Stockholm, are the contractors. There are two dynamos, for 200 and 150 lamps respectively, the out-door lamps being fed by accumulators at times when the inside lamps are not going. The Marieburg Ammunition Works are also to be lighted by electricity.

The Danish Government asks in its present Budget for several grants for electric lighting. One proposed installation is the electric lighting of the large Theatre Royal at Copenhagen, and it is the intention to light the entire building by electricity. For the interior 4,000 lamps are proposed. On the stage the incandescent lamps will be on what is called the three-lamp system, in which each light has lamps of three different colours (white, red, and green), which can be used entirely independently of each other. There has been some doubt whether the electricity should be supplied from an electric central station outside the theatre, or whether the theatre should have its own independent electric station, and the latter has been decided upon as by far the most satisfactory and most cheap.

At the Copenhagen Central Railway Station it is also proposed to introduce electric light, and the Government proposes an installation comprising 24 arc and 100 incandescent lamps. Several grants are also asked for the State telegraphs and telephones; for the latter 50,000kr., mostly for connecting fishing villages, &c. Inland express telegrams will soon be introduced in Denmark, and it is proposed to charge three times the ordinary fee for such messages.

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CORRESPONDENCE.

THE PRACTICAL UNIT OF INDUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Professor Ayrton is, I think, under a misapprehension as to what the Paris Electrical Congress have stated in their resolution about the Practical Unit of Induction. In the copy of the Resolutions which was handed to the British Association Committee by Sir Wm. Thomson and Mr. Preece, and which I understood to be official, the word "secohm" does not occur, neither does it in the text of these resolutions, given in *L'Electricien* for August 31 of this year. The words are simply—

"L'unité practique de coefficient d'induction est le *Quadrant*, 1 quadrant = 10^9 centimetres."

Neither the Congress nor the B. A. Committee assert that a quadrant and a secohm are identical. Of course, if Prof. Ayrton defines secohm in terms of the "legal" ohm, they are not; though why he should adopt the "legal" ohm as the commercial unit of resistance I do not know. The B. A. Committee, it is true, in 1886, in reply to a communication from the Board of Trade, advised the Government "to adopt for a term of ten years the legal ohm of the Paris Congress as a legalised standard sufficiently near to the absolute ohm for commercial purposes," but that recommendation has never been acted on by the Government.

The practical unit of resistance in 10^9 C.-G.-S. units, and the practical unit of induction in electro-magnetic measure is 10^9 centimetres.

And now a few words as to the choice of the word "quadrant." In his article on the "Secohmeter" (*Nature*, June 9th, 1887, p. 131), Prof. Ayrton states that the commercial unit of induction is "about 2·3 in a thousand less than 10^9 centimetres, or one earth's quadrant," thus basing it on the legal ohm. He then proceeds, "Now, in spite of the difference between the two numbers, which, although small, it is a pity to lose sight of, the English word quadrant is not used in French, therefore it would not be well to suggest this word as the international name for the unit." He then goes on "to suggest secohm as a provisional name." It would appear from this that one main reason against adopting "quadrant" was the fear that it would not be recognised in France. At Newcastle, however, the B. A. Committee were brought face to face with the request to adopt "quadrant" because it had been adopted in France. Is it too much to expect that the authors of the word "secohm" should for the sake of international unity surrender their "provisional name" and adopt one which was at any rate mentioned in their original communication on the subject?

As to the definition of the term "Legal Quadrant" which Prof. Ayrton asks for, I should say that a legal quadrant is a length which bears to 10^9 centimetres the same ratio as the resistance of a column of mercury 106 centimetres long, 1 square millimetre in cross-section, at 0° C. bears to 10^9 C.-G.-S. units of resistance. The legal quadrant is thus the same as the secohm as defined by Professor Ayrton, if we assume as he does in his definition that the resistance of the legal ohm is ·99777 ohms.

There is one other point. I sympathise fully with what Mr. Sumpner says as to the suppressed dimensions of μ, and for this reason might have personally preferred a name which would not perpetuate the present incomplete state of our knowledge in a time when we shall come to know more about the nature of magnetic force and magnetic induction; but the fact remained that quadrant had been adopted at Paris, and the objection Mr. Sumpner has raised was not thought sufficiently serious to outbalance the advantage of a uniform nomenclature. The definition as given in the resolution of the B. A. Committee is strictly accurate. On the electro-magnetic system of measurement a coefficient induction is, and always will be, a length.—Yours, &c.,

R. T. GLAZEBROOK.

ELECTRIC TRACTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the notes of your issue of the 18th inst., referring to Electric Traction, you evidently allude to my method of carrying cells, and say:—"There may be, probably there is, something to be said for it." Will you allow me to offer a few remarks, which I think will not be out of place at the present time.

Your electrical readers will not endorse all my views on this matter, but I have tackled the problem from a purely mechanical standpoint. It will be found that a set of 70 E.P.S. Co.'s 19 T cells, their latest traction pattern, having a capacity of 120 ampere hours, and a discharge rate of 40 amperes, will cover 38 square feet of floor—that is, without any carriages or cases for removing them from the car. The available floor space in an ordinary 46-passenger car, clear of all obstructions, is 14ft., or less by 14in. under each seat, 33ft. in all. This cramping of cells is, I maintain, the entire cause of the financial failure of storage cars carrying the cells under the seats.

I shall be told that smaller cells can be made to have a larger capacity and a higher rate of discharge, but at what cost to their life and efficiency? I find that those who have any knowledge of secondary batteries are almost unanimous in the opinion that the plates should be a much greater distance apart than was considered sufficient some year or two ago. I believe Sir David Salomons was the first to suggest increasing the space between the plates, and it has certainly been adopted by the cell-makers of to-day.

Again, it is impossible to run a car into the depôt, taking passengers and all, after every 16 or 20 miles' run, to change the cells, and as all depôts do not happen to be at the ends of the line where the cars are empty, a useless journey would have to be made for that purpose. The tender can be handled in the same manner as horses—run out to the car as it passes, not detaining it more than a minute. There is the further advantage that, once being packed in the tender, the cells are not subject to the rough handling and the sudden shocks they would get in withdrawal from the car, besides the advantage of being able to use a cell of such a size as will ensure a fair efficiency and life.

I quite agree with you that for storage traction two motors on each car are an absurdity; the cells will not stand the double discharge for any length of time, and two motors are of little use if you cannot use them.

The widely different conditions under which a car is required to work, in the London streets at least, makes it a necessity that some means of relieving the strain upon the motor as well as the cells should be provided, and I have adopted in my car two sets of gear, one having a ratio of 1 to 7, and the other 1 to 14; with the motor running at 700 per minute they give 7 and 3½ miles per hour approximately. In our experiments we found it answer very well indeed, by an automatic arrangement the car always starting with the powerful set. But having received some rather severe criticism upon my method of gearing, especially from an esteemed contemporary of yours—who, by the way, has never seen it—and not having absolute faith in my own infallibility, I have for some time past been experimenting upon a fresh method of gearing, retaining the two ratios as before, and I am glad to say with some measure of success, which I shall be only too glad to describe as soon as I find it to be absolutely reliable.

Respecting my double armature motor, I know very few electricians will admit it is necessary, although all makers of dynamos and motors manage to get the price of a "*spare armature*" into their price lists, and I have yet to learn that an armature wears out. I submit it is rather handy to have a spare one, which, by the movement of a hand-wheel, can be made to take the place of one that has been disabled or in danger of being damaged.—Yours, &c.,

Victor Works, Holloway, N. W. D. SANDWELL.

THE BIRMINGHAM EXHIBITION AWARDS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the awards recently given at the Birmingham Electrical Exhibition for "gas engines," several reports are in the papers in which we are not mentioned in any way. We should like to inform you that on behalf of Messrs. Crossley Brothers (Limited) we secured the Special Award Gold Medal, for the "Otto" gas engines, and enclosed have pleasure in handing you a letter from the secretary of the Exhibition, in which an explanation is given why our award (which is the highest) was omitted from the list sent to press.

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We should esteem it a favour if you will kindly notice this in your next issue.

Thanking you in anticipation,—Yours, &c.

Birmingham, Oct. 30, 1889. JOHN WRIGHT AND CO.

[COPY.]

SIR: Permit me to explain that a special Gold Medal was awarded to Messrs. John Wright and Co. for the "Otto Gas Engine," by the jurors, but by some oversight their name was omitted from the preliminary list published in the papers. I very much regret such an oversight should have occurred, especially as it was considered that the gas engine exhibited by Messrs. Wright was entitled to the first place in the list of awards.—Yours faithfully,

T. C. SHARP,
Secretary and Manager, Birmingham Exhibition.

THE ZIPERNOWSKY ARC LAMP.*

The Ziperiowsky arc lamp, made by Ganz and Co., of Budapest, is shown in the annexed cuts. The fine wire solenoid E is a shunt

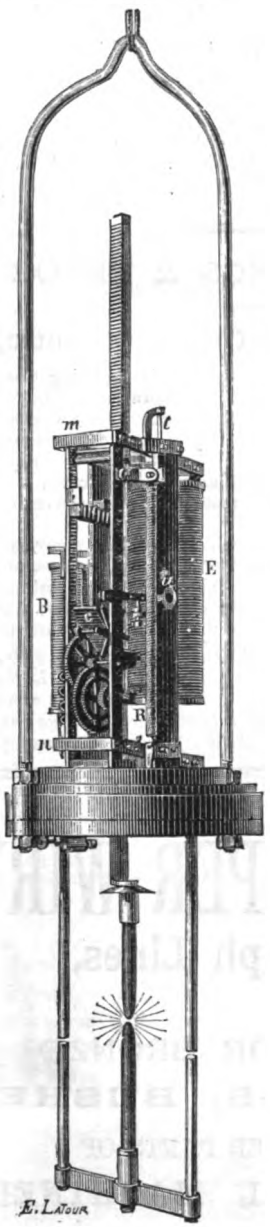

FIG. 1.

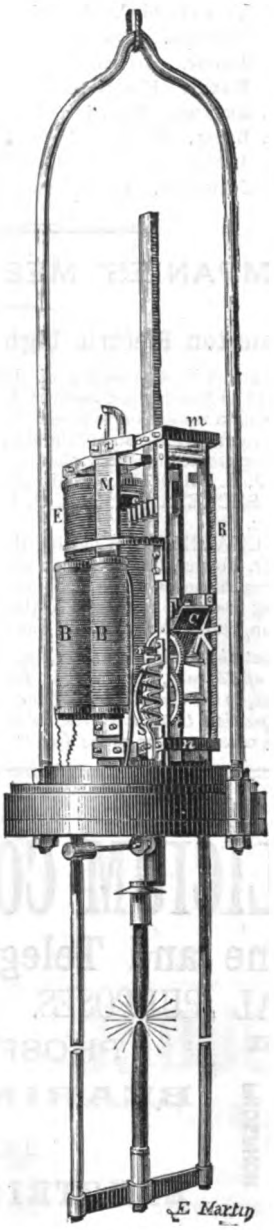

FIG. 2.

to the main circuit. The soft iron core lies almost entirely within the solenoid, and is attached to one end of an oscillating frame, *m*. To the other end of the same frame are attached two vertical bars, which carry a series of toothed wheels, and which are joined at the bottom to a second oscillating frame, *n*. The clockwork, therefore, participates in the movements of the two vertical bars of the parallelogram *m n*, but the principal wheel engages with the rack to which the positive carbon is connected. The spring R balances the weight of the soft iron core, which tends to lift the clockwork.

When the lamp is out of circuit the core keeps the arrangement of wheels in its highest position, and the arm *a* (Fig. 1) brakes the star-wheel, which is on the same spindle as the fly-wheel *c*. The rack cannot, therefore, descend, and the carbons are apart. When the lamp is switched in, the current traverses the solenoid, and the core, attracted upwards, lowers the other end of the parallelogram, and brings the carbons into contact. At the same instant the solenoid current becomes weak, the clockwork and the positive rod, therefore, lift and the arc is struck, When the arc becomes too long, the power of the solenoid increases and the upward movement of the core causes the part *m n* of the parallelogram to descend; the lever *a* (Fig. 1) meets a stop, and being lifted frees the star-wheel. The positive carbon then feeds down until the arc attains its normal length, when the lifting of the clockwork brings the brake again into play.

When the carbons are nearly consumed the arc is broken, and the current is shunted through the coils of the electro magnet BB (Fig. 2), which are brought into circuit by the carbon-holder meeting a special metal contact arranged underneath the base of the lamp. The electro magnet BB now attracts its armature, which is fixed to the oscillating frame; the end *m n* is pulled down, and the spring S (Fig. 2) is pressed against the base plate, short circuiting the lamp. To ensure smooth working there is an air dash-pot established within the solenoid core itself, the piston of which is fixed at *t*.

* Translated from M. Hippolyte Fontaine's "Éclairage à l'Electricité," by kind permission of the Author.

BOOKS, &c., RECEIVED.

"Elementary Manual of Magnetism and Electricity." Part I., Magnetism. By Prof. Jamieson, M.I.C.E. (London: Charles Griffin and Co.)

"Catalogue of Electrical Apparatus." (Ernest Scott and Co., Newcastle-on-Tyne.)

Proceedings of the American Association for the Advancement of Science. Thirty-seventh Meeting, held at Cleveland, August, 1888.

"L'Energie et ses Transformations." By R. Colson. (Paris: Georges Carré.)

Catalogue of Electric Light Fittings. Winfields (Limited), Birmingham.

"Sound, Light, and Heat." Sixteenth edition (revised). By Alfonzo Gardiner. (London: John Heywood.)

Transactions of the Institution of Civil Engineers of Ireland. Vol. XIX. (Dublin.)

LEGAL INTELLIGENCE.

The Queen v. Redman.

This was a case heard before Mr. Baron Huddleston and Mr. Justice Mathew, on Monday, under the Metropolitan Building Act, in which a rule was applied for against the district surveyor of Deptford that he should show cause why he should not be ordered to put in force the provisions of the Act. It appeared that the London Electric Supply Company, whose premises were next to the General Steam Navigation Company's premises, although they had deposited plans which were in accordance with the schedule to the Act, had erected a wall which did not comply with the conditions of the statute, not having proper footings, &c. The building operations were finished in March, 1888, and no steps were taken until February, 1889, to enforce the Act, as the contraventions of the Act were only discovered by digging in November, 1888. The district surveyor had refused to put the Act in force.

The Attorney-General (Sir Richard Webster, Q.C.), with him Mr. Cripps, appeared for the rule; Mr. Finlay, Q.C, and Mr. Bremner appeared to show cause; Mr. E. Harrison was for the London County Council.

Mr. FINLAY argued that the rule was discretionary, and that (1) there was too great a delay to justify a mandamus being issued; (2) that the plaintiffs should have proceeded under the clauses with reference to dangerous buildings; and (3) the plaintiffs had another remedy by action which they were enforcing in another Court.

The ATTORNEY-GENERAL argued that there had been no delay, because the work the Electric Company had done was done behind the back of the General Steam Navigation Company; that the non-compliance with the Act was only discovered some time after by digging, and that, though there might be a remedy as between the two companies as private corporations, such remedy did not debar their right to compel a public officer to perform his duty.

Mr. BARON HUDDLESTON gave judgment as follows:—It is clear that there has been no delay, since the work was done surreptitiously, and as soon as it was discovered by digging, proceedings were taken. The Act is for the protection of the public, and it is clear that the statutory requirements have not been complied with. Mandamus must go.

Mr. Justice MATHEW concurred.

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PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned applications are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions.*

October 10, 1889.

15,968. W. C. JOHNSON and S. E. PHILLIPS. London. Improvements in insulating supports for underground electrical conductors.

15,974. S. P. BLACKMORE. London. Improvements in electric arc lamps.

October 11, 1889.

16,036. W. E. IRISH. London. Improvements in galvanic batteries.

October 12, 1889.

16,052. C. CUMMINGS. Dublin. A new or improved electric safety device.

16,065. P. VON KNOBLOCH. Sheffield. Improvements in electro-motors.

16,084. E. DE PASS. London. Improvements in electricity meters (E. Marès, France).

October 14, 1889.

16,144. H. HAYMAN. London. An improved electric tell-tale clock (A. Gundersen, New Zealand).

16,148. H. STUDTE. London. A new or improved invisible portable contact for house telegraphs and electric conductors.

16,165. E. W. LANCASTER. London. Improvements in electrical fusible cut-outs (C. Grivolas, France).

October 15, 1889.

16,210. A. WOLFSCHMIDT and C. BREHM. Liverpool. Improvements in electric dry batteries.

16,231. G. PFAUMKUCHE. London. Improvements in dynamo-electric generators.

16,241. H. H. CARPENTER. London. Improvements in secondary or electric storage batteries.

October 16, 1889.

16,275. G. H. BASSANO. Derby. Improvements in electrical switches.

16,331. J. CLEGG. London. Improvements in the manufacture of illuminants or light-emitting conductors of electric lamps.

October 17, 1889.

16,366. D. SINCLAIR and H. F. JACKSON. Glasgow. Improvements in electric cables.

16,374. A. SERRAILLIER and G. P. ARMSTRONG. London. An improved portable electric lamp.

16,375. C. B. DE MONTAUD. London. Improvements in secondary batteries.

October 18, 1889.

16,466. C. NICHOLAS. London. Improvements in electric meters.

16,500. F. V. MAQUAIRE. London. Improvements in and relating to electric regulators or balances.

October 19, 1889.

16,537. D. RYLANDS. London. Improvements relating to insulators for electric wires, and to supports therefor.

16,564. H. H. LAKE. London. Improvements in apparatus for winding clocks by electricity (F. E. Morgan, United States).

October 21, 1889.

16,586. T. MARCHER and F. ERNECKE. London. Improvements in circuit closers.

16,599. C. ADAMS-RANDALL. London. Improvements in and relating to electric date and time stamps.

October 22, 1889.

16,648. M. WHELESS and S. E. WHEATLEY. London. An improved electric railway system.

16,655. W. J. BREWER. London. Improvements in electric storage batteries.

SPECIFICATIONS PUBLISHED.

1888.

13,687. CROMPTON. Electrical furnaces. (Price 8d.)

13,805. WYNNE. Applying electricity to vehicles. (Price 11d.)

14,095. SWINBURNE. Dynamo-electric machines. (Price 8d.)

14,322. MILLER. Galvanic cell. (Price 8d.)

14,323. MILLER. Electrolyte. (Price 4d.)

15,395. CARDEW. Measuring electric currents, &c. (Price 8d.)

15,494. ORLOFF. Operating dynamos. (Price 6d.)

15,530. PAUL. Electric indicators. (Price 8d.)

16,471. RAWORTH. Dynamo-electric machines. (Price 11d.)

1889.

6,104. LAKE (Tibbits). Incandescent electric lamps. (Price 8d.)

6,285. PRENTICE. Dynamo-electric machines. (Price 6d.)

9,508. SPERRY. Arc lamps. (Price 8d.)

11,019. WEEMS. Electric railways. (Price 1s. 1d.)

11,471. REYNIER. Electric accumulators. (Price 8d.)

11,780. BUOLL. Dynamo-electric generators. (Price 8d.)

12,145. JUSTICE (Acheson). Generating electricity. (Price 8d.)

12,760. SALISBURY. Electric motor for street cars. (Price 11d.)

COMPANIES' MEETINGS & REPORTS.

Taunton Electric Lighting Company (Limited).

An extraordinary meeting of the Taunton Electric Lighting Company was held on Monday last week, at the Castle Hotel, Taunton, for the purpose of passing a resolution to create 2,000 new shares of £5 each, necessitated by the increased demand of the electric light, to provide which new premises are being erected and new plant purchased.

Mr. J. H. BALE (Vice-Chairman of the Company) presided.

The SECRETARY (Mr. F. C. Bostock), read the notice convening the meeting.

The CHAIRMAN, in moving the first resolution, said he was very sorry that Mr. Fowler, the Chairman of the Board of Directors, was not present. The circumstances which had given rise to the necessity of calling this meeting would be explained to them by their Managing Director, Mr. Massingham, and all he would do was to propose the following resolution :—

"*That the capital of the Company be increased by creating 2,000 new shares of £5 each, and that the Directors be empowered to offer, in the first instance, to the shareholders of the Company willing to accept the same, and in proportion to their several holdings, and subject thereto to issue and allot in such other manner as the Directors may think expedient, all or any of such*

PATENT
SILICIUM BRONZE AND SILICIUM COPPER WIRE.
The best for overhead Telephone and Telegraph Lines,
AND ALL ELECTRICAL PURPOSES.
Hard Drawn High Conductivity Copper Wire.
ROLLED AND DRAWN
PHOSPHOR BRONZE.
PHOSPHOR BRONZE
BEARINGS, BUSHES,
AND OTHER PARTS OF
ELECTRICAL MACHINERY.
SOLE PROPRIETORS of the British, Indian and Colonial Patents,
THE PHOSPHOR BRONZE COMPANY (Limited),
87, Sumner Street, Southwark, London, S.E.
WIRE AND SHEET MILLS: BAGOT STREET, BIRMINGHAM.

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new shares, at such time or times, and at any premium, and generally on such terms and conditions in all respects as the Directors may determine."

Mr. H. G. MASSINGHAM, in seconding the adoption of the report, said he was extremely pleased that the finances of the Company necessitated such a resolution being passed. It was four years ago since the electric light was introduced into Taunton. They had then only one dynamo. Now they possessed six dynamos, and their works would hold no more, so that at the present time they were obliged to refuse further custom. They had been in that position for some months now, and the Directors had to choose between two alternatives—to refuse custom or increase their works. They had decided to adopt the latter alternative, and as their present works were not capable of extension the Directors had purchased a plot of land, which had been known as St. James's Vicarage, and upon that they were building an entirely new depôt. When completed he thought it would be a model depôt, and something worth showing those numerous deputations who, during the past three or four years, had visited Taunton from all parts of the United Kingdom. He was very pleased to say that as a result of the visits they had received, and especially of the visits of electrical engineers, the electric light industry had received a great impetus throughout the country. Amongst the gentlemen who had been to Taunton to see the light he might mention the late President of the British Association, Sir F. Bramwell, who had been asked to advise the Corporation of Bedford as to the advisability of introducing the electric light in the town. Previous to his visit a deputation from the Corporation came to Taunton, and they were so pleased that they asked Sir Frederick Bramwell to see the Taunton depôt too. Major Waller, secretary of the London Electric Supply Corporation, who were building huge works at Deptford, had also been down to inspect the works, and practically all that had been done in London was an imitation of what they had successfully accomplished in Taunton; but Taunton had done it on a small scale, and the Londoners were going to do it on a more gigantic scale. He also referred to the report of Mr. Preece, who was advising Bristol, who, although largely interested in gas, had no fear that electricity would do away with gas. He practically supported their experience that the introduction of the electric light was no morelikely to do away with the use of gas than the steam engine had done away with horses, which many predicted would be the case when the steam engine was first introduced. Mr. Preece also further advised the Corporation of Bristol to adopt the same system of distribution which had been so successfully introduced in Taunton, Exeter, and Bath. These three towns out of the whole of the United Kingdom he specially mentioned, and it was extremely gratifying to him (Mr. Massingham) personally because he happened to be associated with the introduction of the electric light in those places. In Exeter he held a similar position to that he held in Taunton, while in the case of Bath the electric light works were his own property. The Corporation of Bath had given him a seven years' contract for the lighting of 50 of the principal streets, squares, and crescents on the Thomson-Houston system. It was the largest public electric lighting contract ever yet attempted in this country. Mr. Massingham then read extracts from Taunton, Bath, and Exeter papers to show the growing appreciation of the light. With regard to Bath it was reported that the Grand Pump Room Hotel was to be lit throughout by electricity, and the work had already commenced. So they saw that in the West of England the electric light was progressing very fairly indeed. At the present time the share capital of the Taunton Company was £9,125, and in addition to that they had £3,000 in debentures. When the Directors last had the pleasure of meeting them their share capital was a little under £5,000. They then offered shares to the public, and the whole of them had been taken up, and they were in this position now—with the exception of £875, that was practically all they could issue, and he might mention that they had applications for more than that amount already. They were now obliged to call this meeting for the purpose of increasing the nominal capital of the Company, so that they might be in a position to issue shares when applied for to enable them to pay for the new depôt. Another thing he thought he ought to touch upon was the price. He found that the price at which the electric light was supplied in Taunton was lower than that charged in any other town in the United Kingdom, with the exception of Bath and Exeter, where it was the same. As far as he could ascertain, it was lower than had been charged anywhere on the Continent or in America. In fact, he believed it was the lowest in price of any place in the world. The average price of the electric light in London was 100 per cent. more than was charged in Taunton, even in competition with those large companies with their enormous capital and greater power. He found, too, that in the case of the Eastbourne, Brighton and Hastings Company the average charges were 200 per cent. more than they were charging in Taunton, so that there was no disguising the fact that Tauntonians were in a position to enjoy one of the greatest products of science at a price that no other community in this country could possibly command, and he sincerely hoped when they put down the new plant they should have a large acquisition of customers.

Mr. W. POTTER supported the resolution, and said their nominal share capital at first was £10,000, and of that sum they only called up £5,000, that modest sum being deemed sufficient for the requirements of the moment, but as the demand for the light increased, and they knew as well as he did how rapid had been that demand, it was necessary to call up the additional £5,000, and the ready way in which that call was responded to was not only very satisfactory to the Directors, but it showed in the most conclusive manner how, during the two years of its existence, the Company had grown in public favour, and the confidence it inspired in the public mind as a safe and profitable investment. The Directors in asking them that night to increase their share capital to £20,000, and in going to the public and asking them to subscribe, thought they could do so with confidence from the success they had achieved in the past.

The resolution was put to the meeting and carried unanimously.

A vote of thanks to the Chairman was given, on the motion of Mr. WAKEFIELD, seconded by Mr. A. STEEVENS, and the proceedings terminated.

CITY NOTES, &c.

BIRMINGHAM SAFE DEPOSIT COMPANY (LIMITED).—This company was registered on the 18th inst., with a capital of £20,000, in £5 shares, to carry on the business of a safe deposit company, and also of gas, electrical, and mechanical engineers. Registered without special articles.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The receipts of this company for the week ended October 25 amounted to £4,191.

ELECTRICAL ACCESSORIES COMPANY.—This company has purchased the works and business of Mr. S. Atkins, of Hockley Hill, Birmingham. A specialty of their manufactures will be the Atkins Universal Shade Carrier.

ELECTRICAL AUTOMATIC DELIVERY BOX COMPANY.—Mr. F. G. Painter (of the firm of Tribe, Clarke, Painter, and Co., Moorgate-street) has been appointed official liquidator of this company.

INDO-EUROPEAN TELEGRAPH COMPANY.—The Board of Directors of this Company have declared an interim dividend for the half-year ended the 30th June last, at the rate of 5 per cent per annum, free of income tax, payable on and after the 1st November.

THE NATIONAL ELECTRIC SUPPLY COMPANY (LIMITED).—This Company has been formed with a capital of £100,000, in 19,900 ordinary shares and 100 founders' shares of £5 each, to carry on in England or elsewhere the trade and business of electric lighting and the supply of electric force and motive power for communication or locomotion. First directors shall be Charles Herbert Cobbold, Dan Rylands, Thomas Robinson, and Walter Emmett, and three others may be added to the board. Qualification, 50 shares, or £250 stock. Remuneration, £100 per annum each (chairman £200), and further by vote in general meeting. Registered by S. Learoyd and James, solicitors for the Company, 12, Coleman-street.

LLANELLY ELECTRIC LIGHT AND POWER COMPANY.—This company has been registered with a capital of £15,000, in £1 shares. Objects: To generate, produce, and distribute electricity for the purpose of lighting streets and public and private buildings, and for supplying electric motive power.

NATIONAL TELEPHONE COMPANY.—The Committee of the Stock Exchange have ordered shares Nos. 1 to 386,875 of the National Telephone Company to be quoted in lieu of those of the United Telephone Company.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—At a meeting of the Board of Directors of this Company held yesterday it was decided that, after placing £7,500 to the renewal fund, and £5,600 to the Debenture redemption fund, the Directors would recommend at the forthcoming meeting a dividend of 6s. per share (free of income-tax), being at the rate of £4 per cent. per annum for the six months ended 30th June last. The transfer books will be closed from the 6th to the 10th November, both days inclusive.—The traffic receipts for the week ended October 25, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,739.

THE NON-CONDUCTOR OF ELECTRICITY.

WAREHOUSE.

VULCANISED FIBRE,

PATENTED.

This new material is supplied in two qualities, Flexible and Hard.

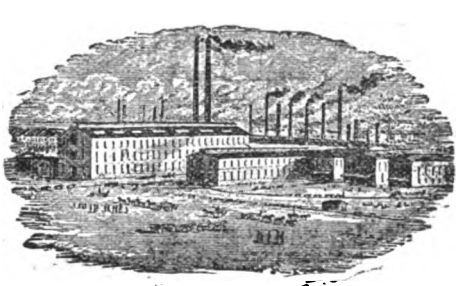
The FLEXIBLE is a substitute for Leather, Rubber, Gutta Percha, &c., and is extensively used by Brass Founders, Axle Makers, Hydraulic, Sanitary, and other Engineers, Pump Makers, Carriage Builders, &c.

It makes the best Hot and Cold Water Packings, and for Axle Washers of all kinds it is unequalled.

The HARD is a substitute for Metals, Hard Wood, Ivory, Vulcanite, Ebonite, &c., and is a good Insulator.

Sold in sheets, 5ft. 6in. by 3ft. 6in., varying in thickness from 1-50in. to 1in.

FLEXIBLE, 2/- per lb.; HARD, 2/3 per lb.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MOSSES & MITCHELL, 70 Chiswell-st., London, E.C.

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COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name	Price, Wednesday, Oct. 30, 1889.	Rate per Cent. Yielded.	Dividend Due.	Business Done during Week Ending Oct. 30, 1889.	
£			**TELEGRAPHS.**		£ s. d.		Highest.	Lowest.
1,770,360	Stock	15/0	Anglo-American	50½ 51⅛	4 17 1	Jan., Apr., July, Oct.	51¼	50¾
2,614,320	Stock	30/0	Do. Preferred	86½ 87½	5 14 3	,, ,,	87¼	86½
2,614,320	Stock	...	Do. Deferred	16¾ 17¼	...	February	17	16⅞
130,000	£10	5/0	Brazilian Submarine	13 13½	5 18 6	Mar., June, Oct., Dec.	13⅜	...
112,900	£100	5%	Do. 5 per Cent. Bonds	101 103	4 16 0	January and July	...	...
75,000	£100	5%	Do. Do. (2nd Series, 1906)	106 109	4 11 9	June and December.	...	...
16,000	10	9/0	Cuba Submarine	14½ 15	6 0 0	February and August	...	...
6,000	10	10/0	Do. Preference 10%	20 21	4 17 9	,, ,,	...	...
12,931	5	1/7½	Direct Spanish (£4 paid)	3¾ 4¼	3 15 4	March & September	...	...
6,000	5	5/0	Do. Preference 10%	9 10	5 0 0	April and October	...	...
60,710	20	3/6	Direct United States	10½ 10½	5 18 11	Jan., Apr., July, Oct.	10⅝	10½
380,000	10	5/6	Eastern	13¾ 14	4 12 0	,, ,,	13⅛	13⅜
70,000	10	6%	Do. 6 per Cent. Preference	15 15½	3 17 5	,, ,,	15⅜	15½
1,200,000	Stock	4%	Do. 4 per Cent. Mortgage Debenture Stock xd	106 108	3 14 1	May and November.	110	109⅜
200,000	100	5%	Do. 5 per Cent. Debentures, 1899	106 109	4 10 1	February & August	...	...
250,000	10	2/6	Eastern Extension	13⅜ 13⅝	4 15 5	Jan., Apr., July, Oct.	13⅝	13½
320,000	100	6%	Do. 6 per Cent. Debentures, 1891	102 104	3 16 1	February & August	...	...
473,000	100	5%	Do. 5 per Ct. (Austrln. Gov. Sub.) Debs. 1900	104 107	4 13 6	January and July	106	...
179,177	10	4/0	Globe Telegraph and Trust	8⅜ 8⅞	5 4 1	Jan., Apr., July, Oct.	9	8½
178,992	10	3/0	Do. 6 per Cent. Preference	14⅜ 14⅝	4 0 8	,, ,,	14⅞	14⅛
150,000	10	5/0	Great Northern	15½ 15¾	4 15 3	Jan., July, and April	15⅞	...
17,000	25	37/6	Indo-European xd	40 42	5 19 1	April and October	43	...
9,000	8	8/0	Reuter's	7 7½	5 6 5	April and October	7 3/16	7
15,609	10	5/0	West African Telegraph	9 10	...	...	9 1/16	9⅞
300,000	100	5%	Do. 5 per Cent. Debentures	99 102	4 18 0	March & September	101½	...
30,000	10	5/0	West Coast of America	10½ 11	5 0 0	January and July	10¾	10 5/16
150,000	100	8%	Do. Debentures 8%	122 127	6 6 0	June and December	...	...
88,321	10	nil.	West India and Panama	2⅝ 2⅞	...	...	2⅞	2½
84,563	10	12/0	Do. 1st Preference 6%	12 12½	...	April and October	12½	...
4,669	10	†	Do. 6 per Cent. 2nd Preference	14½ 15½	...	...	15⅛	14½
45,181	15	9/0	Western Brazilian	9½ 10	7 10 11	May & November	10	9⅞
$1,500	$1,000	7%	Western Union 7 per Cent. 1st Mortgage	114 118	5 18 8	May and November	...	...
187,500	£100	6%	Do. 6 per Cent. Sterling Bonds	97 100	6 0 0	March & September	...	...
			TELEPHONES.					
224,850	14/0	6%	Consolidated Telephone and Maintenance xd	1⅛ 1⅜	...	Yearly	...	...
220,000	£1	3%	Oriental (11s. paid)	5/16 7/16	...	...	...	...
*	*	...	National	6⅛ 6⅝	...	...	...	...
55,000	5	3%	United River Plate	5 5½	...	January and July	5⅝	...
			ELECTRIC LIGHT.					
23,692	5	2/0	Anglo-American (fully paid)	5 5½	...	February & August	...	...
79,234	5	...	Swan United (£3. 10s. paid)	5¼ 5⅜	...	...	5½	5 7/16
500,000	10	...	Metropolitan Electric Supply (£3 paid)	3½ 4	...	...	3⅞	...
			MISCELLANEOUS.					
37,350	12	12/0	Telegraph Construction and Maintenance	43 45	5 4 9	March and July	45½	44
41,600	10	10/0	India Rubber, Gutta Percha & Telegraph Works	18½ 19	5 5 3	February & August	19	...

† No dividend since May, 1880.

JABLOCHKOFF'S
DISTRIBUTION PATENT

(Being a Patent for "Producing and Dividing Electric Light," No. 1996 of 1877.)

THE UNITED ELECTRICAL ENGINEERING COMPANY (LIMITED)

Are Proprietors of the above Patent, and Warn the Public against Infringement.

The following are Licensees:—

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W. T. Goolden & Co.
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Paterson & Cooper.
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3, Prince's Mansions, Victoria Street, Westminster.

MANVILLE & MADGEN, *Managing Directors.*

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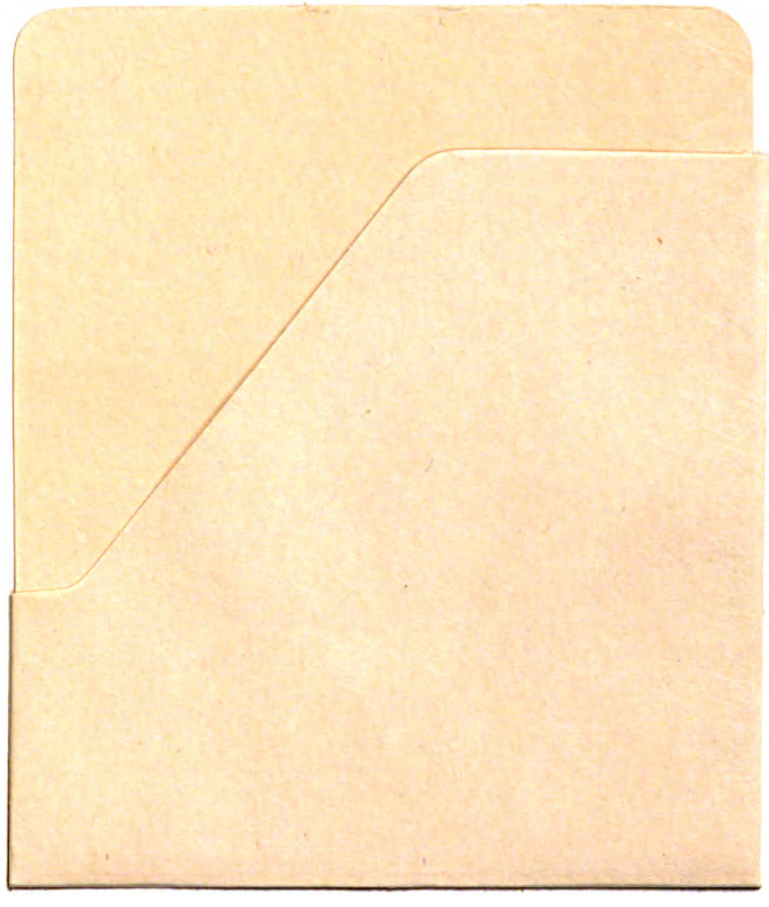

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